REPORT

OF THE

CANADIAN ARCTIC EXPEDITION 1913-18

VOLUME V: BOTANY

PART B: CONTRIBUTIONS TO THE MORPHOLOGY, SYNONYMY, AND GEOGRAPHICAL DISTRIBUTION OF ARCTIC PLANTS

By THEO. HOLM

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Report of the Canadian Arctic Expedition, 1913-18.

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Contributions to the Morphology, Synonymy, and Geographical Distribution of Arctic Plants.

By Theo. Holm, *Clinton, Maryland, U.S.A.*

With six photographs and eighteen figures in the text drawn by the author.

The present contribution is divided into four chapters: I, containing notes on morphological characteristics and synonomy; II, giving the geographical distribution; III, concluding remarks, and IV, the bibliography relative to the distribution.

The fact that the collection made by the expedition contains many interesting species, together with the fact that they have been collected and prepared with great skill and care, has enabled me to examine their various organs, principally the vegetative ones, and I am therefore able to offer some descriptions of ramification, reproduction, hibernation, etc., of which several points are but little known from arctic plants.

Having had the opportunity myself to see the arctic flora, (Nova Zembla and Greenland), and moreover to compare this with the alpine flora (Rocky mountains, Colorado), I naturally feel induced to treat both as far as the scope of the subject will permit. Therefore, in the chapter dealing with the distribution, I have inserted several columns for alpine plants, although the arctic distribution has been given the most extensively, because, in respect to geographical distribution, the arctic and alpine floras are so intimately connected with each other that a discussion of either one alone would give very little information about their history.

Considering together the interesting chapters on geographical distribution in Darwin's "Origin of Species" and Nathorst's "Polarforskningens Bidrag till Forntidens Växtgeografi," we have a most valuable foundation for further studies in this line, and quite especially with reference to the arctic flora.

CHAPTER I. MORPHOLOGICAL CHARACTERISTICS AND SYNONYMY.

GRAMINEAE.

The species collected belong to the following tribes: Phalarideae, Agrostideae, Aveneae, Festuceae, and Hordeae; of these the Festuceae are the best represented. They all are perennial and, concerning the habit, the stoloniferous type is somewhat more frequent than the caespitose one; widely creeping stolons above ground are characteristic of *Glyceria vilfoidea;* subterranean ones of *Poa arctica, Arctagrostis, Dupontia, Festuca rubra* var., *Elymus, Arctophila,* and *Alopecurus;* in the last three genera the stolons attain quite a considerable length and ramify freely. The culms are always simple and usually short, especially so in *Glyceria tenella* and *G. vilfoidea,* while in *Elymus, Arctophila, Arctagrostis,* and *Dupontia,* the height of the culm may reach forty cm. or even a little more. The inflorescence is most often an open, lax-flowered panicle, notably so in *Arctophila, Dupontia,* and *Poa arctica;* a contracted, spike-like inflorescence occurs in *Trisetum, Alopecurus,* and *Calamagrostis;* a spicate one in *Elymus, Agropyrum,* and *Hordeum.* The flowering glume [1] is more or less hairy

[1] The old, well known term "flowering glume" has recently become substituted by "lemma" proposed by Professor C. V. Piper (Science, N.S. vol. XXIII, 1906), and is introduced in various manuals. Not speaking of the fact that "lemma" has been in use for several years before as anatomical term, proposed by Strasburger, it seems unwise to change the old term "flowering glume," since this glume (gluma florens) as well as the empty glumes (glumae vacuae) are bracts of the same order borne on the same rhachis, whereas the "palea" is borne upon a rhacheola, developed from the axil of the flowering glume. Moreover, in speaking of "lemma" in plurals, it is absolutely incorrect, from a linguistic point of view, to write "lemmas" instead of "lemmata."

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in *Elymus*, *Poa abbreviata*, *Festuca rubra* var. *arenaria*, etc.; it is awned in *Alopecurus*, *Trisetum*, *Festuca*, *Bromus*, and in *Hordeum* the awn reaches a considerable length, up to about four cm. In habit these arctic Gramineae do not exhibit any characteristics which might indicate the extreme conditions under which they live. The same observation I have made with respect to the alpine species, notably in the Rocky mountains, Colorado, several of which do not recur in the lowlands. Even the peculiar genus *Pleuropogon* with its rather large, drooping spikelets forming a simple, loose raceme, and of which one species, *P. Sabinii* R. Br., is almost circumpolar, is also represented in California by *P. refractum* Benth. and *P. californicum* Benth.

As compared with the species known from the arctic American archipelago [1] there are only a few types which were not found by the Canadian arctic expedition, for instance: *Hierochloa alpina*, *Agrostis*, *Deschampsia*, *Catabrosa*, and *Pleuropogon*, some of which are widely distributed in the arctic regions. But since Mr. Johansen succeeded in finding several of the small and much more inconspicuous species of *Carex*, there is no reason to believe that the "missing" species of grasses were overlooked.

Arctagrostis latifolia (R. Br.) Griseb.

I have without hesitation referred all the specimens collected by the Canadian expedition to this species although those from Camden bay, Herschel island, and Bernard harbour do resemble *A. arundinacea* (Trin.) Beal, as far as the panicle being more open and the spikelets less compact. According to Grisebach in Ledebour's Flora Rossica (p. 434) *A. arundinacea* is considered merely a variety of *A. latifolia*: "panicula laxiori, palea inferiori (the flowering glume) obsolete 5-nervi." Recently, by Scribner and Merrill,[2] this variety is enumerated as a species with no other distinctive characters than "the branches of the panicle being fasciculate, spreading or ascending," besides some measurements of the culm, leaf, and spikelets. However, judging from the large material which I have examined from the northern regions of both Worlds, there seems to be no doubt of the genus being monotypic, although very variable. Specimens from Siberia, viz: Jenisei, Dudino, thus represent the typical plant as well as the variety, and they were found growing associated with each other; in several specimens of gigantic size from Jakutsk, Siberia, the panicle is very open and the spikelets comparatively small, but the structure of both the empty and the flowering glumes shows no deviation from that of the typical plant; similar specimens from Yukon and St. Paul island, Bering sea, differ in no respect from the type except by their greater size, the more open panicle, and the smaller spikelets. And in this respect *Arctagrostis* agrees with species of several other genera, for instance with *Deschampsia caespitosa*, as represented in the alpine region, the arctic, and the lowlands much farther south; furthermore, in *Festuca ovina* and in many species of *Poa* the panicle may be more or less contracted and the spikelets varying considerably as to size and number of flowers.

Poa abbreviata R. Br. and **P. glauca** M. Vahl.

Small forms of *P. glauca* may sometimes be mistaken for *P. abbreviata*. Lange[3] describes both, calling attention to the characters as follows: *P. abbreviata* R. Br. "Humilis, densissime caespitosa; foliis rigidiusculis, subsetaceo-involutis, acuminato-pungentibus, margine scabriusculis, ligula brevi, obtusiuscula; panicula brevi, simplicissima, subsecunda, ramis in verticillis c. 2 plerumque spiculam solitariam, 3-5-floram gerentibus; glumis acutis, inaequalibus; gluma florens (palea inf.) obovata, trinervia, puberula et inferne longius villosa, obtusissima v. truncata, eroso-denticulata."

[1] Simmons, H. G. A Survey of the Phytogeography of the Arctic American Archipelago. (Lunds Univers. Årsskr. Afd. 2. Bd. 9. Lund, 1913.)
[2] Grasses of Alaska, 1910.
[3] Conspectus Florae Groenlandicae (Medd. om Grønland, Kjøbenhavn, 1880).

The accompanying figure A: 3 I have drawn from a specimen collected in Spitzbergen by Professor A. G. Nathorst.

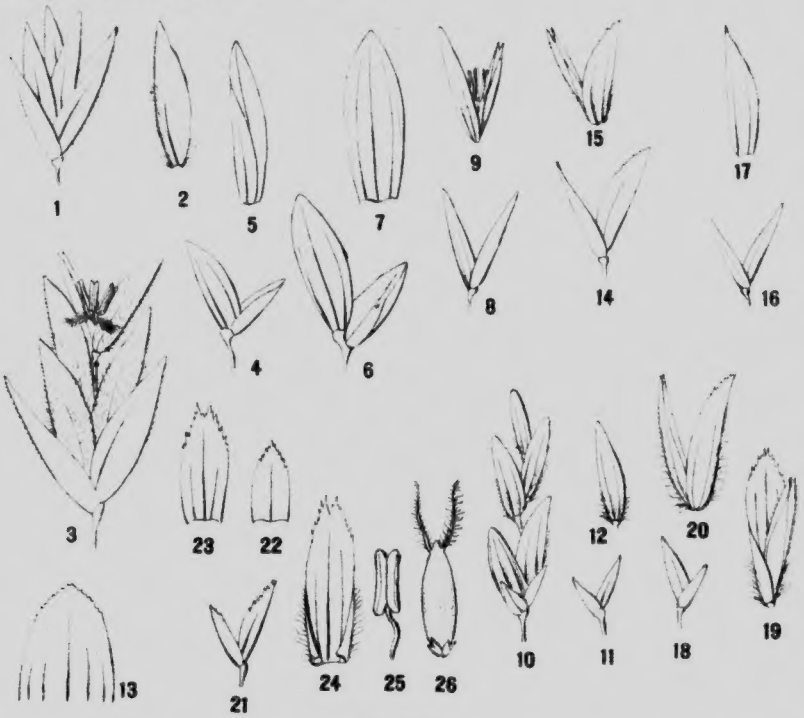

FIGURE A.

1. *Poa glauca* M. Vahl; spikelet. (Wollaston land). 2. Same; flowering glume, side-view. 3. *P. abbreviata* R. Br.; spikelet. (Spitzbergen). 4. *Glyceria vilfoidea* (Ands.) Th. Fr.; empty glume. (Greenland). 5. Same; flowering glume, side-view. 6. *G. maritima* (Huds.) Wg.; empty glumes. (Norway). 7. Same; flowering glume, dorsal view. 8. *G. Vahliana* (Liebm.) Th. Fr.; empty glumes. (Greenland) 9. Same; flowering glume, palet and flower. 10. *G. tenella* Lge.; spikelet. (Martin point, Alaska). 11. Same; empty glumes. 12. Same; flowering glume, side-view. 13. Same; apex of flowering glume. 14. *G. angustata* (R. Br.) Fr.; empty glumes. (Spitzbergen). 15. Same; flowering glume and palet, side-view. 16. *G. paupercula* Holm; empty glumes. (Hudson bay). 17. Same; flowering glume, side-view. 18. *G. vaginata* Lge.; empty glumes. (Cape Bathurst). 19. Same; flowering glume and palet, front-view. 20. Same; flowering glume and palet, side-view. 21. *G. Kjellmanni* Lge.; empty glumes. (Nova Zembla). 22. Same; lower empty glume, dorsal view. 23. Same; upper empty glume, dorsal view. 24. Same; flowering glume, ventral view. 25. Same; a stamen. 26. Same; the pistil with the lodiculae. (All the figures are enlarged.)

P. glauca M. Vahl: "Caespitosa, multicaulis, rigidiuscula, magis minusve glaucescens, spithamaea v. parum ultra; culmis laevibus (*P. caesia*) v. superne scabriusculis (*P. aspera*), articulo superiore elongato; foliis subdistichis, planis v. complicatis, apice curvato cucullato-contractis, ligula brevi, obtusa, folii supremi ovali-oblonga; panicula erecta, angusta, ramis brevibus, ante et post anthesin adpressis, scabris; spiculis 3-5-floris, lanceolato-ovatis; glumis subaequilongis, acutis, violaceis, albomarginatis, gluma florens (palea inf.) 5- nervia, ad nervos sericea et basi lanata. Formae maxime memorabiles sunt: *β elatior* Ands. 1-2′ altus, foliis planis; paniculae ramis longioribus magisque quam in *α* effusis, c. 3-5 in verticillis.

"*γ pallida* Lge. Dense caespitosa, pallide straminea, caespitibus basi vaginarum anni praeteriti reliquis cinctis; foliis angustissimis, complicatis, ligula lacera; spiculis majusculis, lanceolatis, 5-6- floris; gluma florenti et palea lividis, albomarginatis, cum macula aurea sub apice, ad nervos sericeis, ceterum glabris.

"δ *atroviolacea* Lge. Spithamaea, rigida, fol. planis, caulino superiore patulo basin inflorescentiae sub-attingente, ligula elongata, panicula virginea dense coarctata, spiculis subbifloris, glumis longe acuminatis, atroviolaceis, gluma florente et palea basi viridibus albomarginatis, apice purpureo-marginatis."

The spikelets (Fig. A: 1-2) are from a typical specimen collected on Wollaston land.

In *P. abbreviata* the broad empty glumes as well as the flowering glume, the latter being puberulent on the sides and along the keel, constitute a good distinction, when compared with *P. glauca*, in which the glumes are much narrower, and the flowering glume hairy only on the keel.

P. arctica R. Br.

There is no doubt about this being the same as *P. flexuosa* Wahlenb., but it is debatable whether it is to be considered identical with *P. cenisia* All. Lange (l.c. p. 178) states for instance: "Nomen *P. cenisiæ* All., quod a pluribus autt. huc relatum est, non ad hanc speciem spectare videtur, si cum Gren. et Godr. ad *P. distichophyllam* Gaud., a nostra bene distinctam, *P. cenisia* ut synonymon ducitur.

"*P. arctica* R. Br. vero ex consensu plur. autt. omnino eadem cum nostra; utrum horum nominum praeferri debet, incertum videtur, cum uno eodemque anno (1824) publicata sunt."

As pointed out by Lange, (l.c. p. 178) *P. arctica* is readily distinguished by the spreading, flexuose branches of the short panicle; by the ovate, 2-4- flowered spikelets of which the glumes are purplish and of which the flowering glume is obtuse or roundish at apex, with a broad, hyaline margin, villous at the base, and pilose along the veins. The rhizome is stoloniferous.

Arctophila Rupr.

The old genus *Colpodium* of Trinius [1] was founded upon two species: *monandrum* and *Steveni*, which by Trinius himself were considered as "species facie dissimiles," and they are indeed so unlike that Robert Brown [2] a few years later segregated the former as *Phippsia algida* R. Br. and retained the latter only as a *Colpodium*. To the latter genus was furthermore referred *C. latifolium* R. Br. although Robert Brown was not certain about the real affinity of this species to those of Trinius and especially not to *C. Steveni* and *compressum*. At present Robert Brown's species *latifolium* is generally placed under Grisebach's genus *Arctagrostis* as *A. latifolia* (R. Br.) Griseb.

While *Colpodium* of Trinius was adopted by Grisebach [3] with the omission of *C. monandrum* (*Phippsia*), the genus was nevertheless augmented with certain species placed as a section "*Arctophila*" in contrast to *C. Steveni* and its natural allies representing the section "*Eucolpodium*." By including the species of *Arctophila* Rupr., the genus *Colpodium* became actually an aggregate of incongruities, as it had been before with *Phippsia* and *Arctagrostis* included. By Bentham the genus was finally restricted to the section *Eucolpodium*, while *Arctophila* became transferred to *Graphephorum* Desv., next to *Glyceria* R. Br.; another disposition was made by Hackel who followed Grisebach by placing both *Eucolpodium* and *Arctophila* as sections of the original genus *Colpodium*, characterizing them as having the "spikelets one to two-flowered, etc." This same classification is also followed by Beal [4] in his Monograph of North American Grasses, with the same erroneous characterization; erroneous, because it was originally intended for *Colpodium* alone in the sense of Trinius.

[1] Trinius: Fundamenta Agrostographia. 1820. p. 119.
[2] Brown, Robert: Chloris Melvilliana. 1823. (Miscell. bot. works, I, p. 221).
[3] Ledebour: Flora Rossica. IV. 1853, p. 384.
[4] Beal, W. J.: Grasses of North America, II. New York, 1896, p. 556.

Three species are enumerated by Beal as representatives of the genus *Colpodium* in North America: *C. fulvum* (Trin.) Griseb., *C. pendulinum* (Laestad.) Griseb., and *C. mucronatum* (Hack.) Beal. Considering the fact that *Colpodium* in the sense of Trinius was originally intended for both *C. Steveni* and *Phippsia algida*, it seems difficult to find any good ground for admitting species of so little affinity as those of *Arctophila* and still crediting the genus to Trinius. And the species of *Arctophila* have themselves been transferred from one genus to another. Thus we find them as members of *Poa*, *Glyceria*, *Graphephorum*, and finally of *Colpodium*.

Considered by themselves, the species of Ruprecht's *Arctophila*[1] constitute an excellent little genus, and we might cite Ruprecht's own words when he proposed the genus in his "Flores Samojedorum cisuralensium":

"*Arctophila* a *Catabrosa* (*airoide*) praesertim differt glumarum conformatione et longitudine, hac nota etiam et insuper valvulis ecostatis a *Glyceria* R. Br. recedit. *Atropis* Trin. (*P. distans*) *Catabrosae* quoad glumas proxima, spiculas habet (saltem in statu virgineo) lineares, fere teretes; in *Arctophila* nostra semper ex ovato-oblongae vel lanceolatae. Conjunctioni *Arctophilae* cum *Poa* obstant: valvulae dorso concavae vel saltem minus compressae; flosculi lana numquam cincti, nec ad nervos dorsales sericei, sed ad callum more *Avenacearum* pilis rigidis obsiti; valvula inferior apice vix integerrima, sed margo plerumque irregulariter denticulatus et erosus, saltem crenulatus et apex saepe obtusus vel truncatus; habitus etiam nobilior colore fulvo paniculae saepe intermixto; spiculae majores plerumque et flosculi demum patuli, remotiusculi."

The species that are best known are: *Arctophila fulva* (Trin.) Rupr., *A. pendulina* (Laestad.) Ands., and *A. effusa* Lge., especially the first of these since the Greenland plant, *A. effusa*, was for many years considered identical with *A. pendulina* by Fries, Grisebach, and several other authors.

The species found by Mr. Johansen is *A. effusa* Lge., described in Conspectus Fl. Groenl. as follows: "Satis superque differt planta groenlandica, in Fl. Dan. tab. 2343 nomine *Poae pendulinae* divulgata, a *Glyceria pendulina* Laest. vera, Lapponiae tornensis et rossicae incola, statura humiliore foliis brevioribus, culmo erecto (nec apice nutante), ramis deflexis, in verticillo 1-2, raro 3, flosculis in spicula 2-3 (nec 3-6) minus laxe dispositis, glumis obtusiusculis, spicula parum brevioribus, etc. Botanici plures (I. Vahl, Fries, Ledebour, etc.) has 2 species, inter se valde dissimiles, infauste junxerunt, quare plantam Groenlandicam l.c. nomine novo designare coactus sum."

West Greenland, between 64° 10′ and 65° 20′, in damp situations, very rare; Sukkertoppen, Godthaab (Vahl).

A depauperate form of this species is known from Spitzbergen, formerly considered as distinct and named *Colpodium Malmgreni* Ands.[2]

While Grisebach (l.c.) only recognized *A. fulva* and *A. pendulina*, seven other species had been described by Ruprecht (l.c.) but merely referred to as synonyms in Flora Rossica; they were collected on the island Kolgujew and on the Russian coast near Kambalnitza and Bjelaja.

The genus seems to be rare in North America, but specimens belonging to it have been collected in various parts of Alaska and adjacent islands and also in Canada. These specimens have been generally identified as *A. fulva* or *A. pendulina;* of these the former is known only from Muckelung river and the Hudson bay region, and, so far as I know, *A. pendulina* has never been found on this continent.

In the copious material sent to me for identification from the Canadian Government, I found four species, which appeared distinct, and of which three have been described and figured in my paper: On the genus *Arctophila* Rupr.[3]

[1] Ruprecht, F. J.: Symbolae ad historiam et geographiam plantarum Rossicarum. 1846, p. 62–65.
[2] Anderson, N. J. Bidrag till den nordiska Floran I. Ett hittills obeskrifvet gräs från Spetsbergen. (Öfvers. Kongl. Vet. Akad. Förhdlgr. No. 5, p. 121, Stockholm, 1866.)
[3] The Ottawa Naturalist, June, 1902, p. 83.

The species *A. gracilis* nob. from north of Lake Superior, collected by Dr. R. Bell; *A. brizoides* nob. from St. Paul island, Bering sea, by James M. Macoun, and *A. chrysantha* nob. from sixteen miles west of Nome city, Alaska, by J. B. Flett. Furthermore *A. trichopoda* nob. from Mansfield island and Nottingham island, Hudson bay, collected by Dr. R. Bell, and of which the diagnosis [1] reads as follows:

"Stoloniferous: culms weak, about twenty cm. in height, enclosed by the leaf-sheaths: leaf-blades broad, flat and glabrous, longer than the internodes: inflorescence a lax-flowered panicle with the glabrous, capillary branches in twos and threes: spikelet three-flowered, one or two on each branch: empty glumes unequal, quite broad, acuminate, membranaceous, three-nerved: flowering glume broad, pointed and often awned, at least in the basal flower, hairy at the base: palet bidentate, shorter than the flowering glume. A near ally of *A. mucronata* Hack."

Finally may be mentioned that John Murdoch collected an *Arctophila* near Point Barrow which Hackel has described as *A. mucronata, fide* Beal: Grasses of North America.[2] The diagnosis reads as follows:

"A smooth, stout grass, 15-25 cm. high. Leaves 6-8 in number crowded; ligule broad, lacerate, 2 mm. long; blades flat, abruptly pointed, 5-12 cm. long, 6 m.m. wide. Panicle shining, yellowish, open, partially included, narrow or pyramidal, 5-7 mm. long, rays in twos or fours, reflexed, the longest 3-7 cm. long, bearing 2-3 spikelets near the apex. Spikelets 2-flowered, joint of rachilla 0,6 m.m. long, smooth or very sparingly hairy; empty glumes subequal, 3-3, 3 m.m. long, soft, thin, first ovate, 1-nerved, second broader, 3-nerved; floral glume broadly oval, 3,5 m.m. long, 3 mm. wide, 5-nerved, margin scarious, apex irregularly toothed or torn, the central nerve extending to the tip or into a short mucro; palea broad; 1,5 mm. long."

It is thus characteristic of *A. trichopoda* and *A. mucronata* that the midrib of the flowering glume is extended into an arista in the former, and in a mucro in the latter, while in all the other species the midrib does not extend beyond the apex of the glume, a structure which certainly would be anomalous in the genus *Colpodium* Trin. (as understood by Bentham), because there the midrib never reaches the top of the glume.

These species of *Arctophila* may naturally be classified in two sections:

I. *Macrostachyae.*

Spikelets, when fully developed, five- to seven-flowered, the base acute during anthesis.

A. fulva, A. remotiflora, and *A. pendulina.*

II. *Brachystachyae.*

Spikelets two- to four-flowered, the base obtuse during anthesis.

A. brizoides, A. chrysantha, A. deflexa, A. gracilis, A. latiflora, A. mucronata, A. poecilantha, A. scleroclada, A. similis, and *A. trichopoda.*

Dupontia R. Br.

The genus was established by Robert Brown [3] and characterized as follows: "Gluma subaequivalvis, scariosa, concava, mutica, locustam 2-3-floram subaequans. Perianthia mutica, scariosa, (basi barbata), altero pedicellato; valvulis integris, inferiore concava. Lodiculae 2. Ovarium imberbe. Stigmata subsessilia. Caryopsis———. Gramen glabrum erectum. Folia linearia, plana, vaginis semifissis, basi integra. Panicula simplex, coarctata, fusco et purpurascenti varia, pedicellis cum locustis continuis, perianthiis separatim solubilibus."

The genus was named in honor of Monsieur Dupont of Paris, author of a valuable essay on the sheath of the leaves of grasses, and of observations on the genus *Atriplex.*

[1] Fedde's Repert. l.c.
[2] Vol. 2, New York, 1896, p. 556.
[3] Chloris Melvilliana l.c., p. 228.

Only one species, *D. Fischeri*, was known to Robert Brown, but since then Ruprecht (l.c.) has described a second one, *D. psilosantha*, from Kolgujew island, and a third one, *D. micrantha* nob., has been found in Labrador: Halton, and at cape Henrietta Maria, Hudson bay.

Of these *D. psilosantha* differs from *D. Fischeri* by the empty glumes being "acutissimae, caudatae," and by the flowering glume being "(flosculi) glaberrimi, acuminati," while in *D. Fischeri* the empty glumes are more or less obtuse and the flowering glume obtuse and pilose at the base; the third species, *D. micrantha*, differs from both by the small size of the mostly one-flowered spikelets, etc. according to the diagnosis:[1]

"Stoloniferous: culm slender, glabrous, about twenty-five cm. in height: leaves very narrow, glabrous with prominent ligule: inflorescence a contracted panicle with capillary branches: spikelets one or two on each branch, mostly one-flowered: empty glumes unequal, very narrow and sharply pointed, membranaceous: flowering glume acute, slightly hairy at the base, not exceeding the superior empty glume: palet bidentate, a little shorter than the flowering glume."

Glyceria R. Br.

The segregation of *Atropis* originated with Ruprecht[2] and was accepted by Grisebach in Flora Rossica: "genus a *Glyceria* imprimis stylo ad basin usque simpliciter plumosa distinctum est." Meanwhile Parlatore[3] established the genus *Puccinellia* containing the same species as *Atropis* and formerly by Elias Fries[4] referred to his section *Heleochloa* of *Glyceria*. According to Fries (l.c. 1846) *Glyceria* consists of two sections: "*Hydrochloa* Hartm.," with the flowering glume 7-nerved, and "*Heleochloa* Fr." with the flowering glume 5-nerved.

As a section *Atropis* has been recognized by various writers, and much more so than *Puccinellia*. Buchenau[5], however, treats *Glyceria* and *Atropis* as distinct genera, and this author is one of the very few who furnishes a sufficiently complete diagnosis. In Gray's Manual (1908), *Puccinellia* is accepted as a genus, though poorly defined as distinct from *Glyceria;* more recently we find the same disposition by Fernald and Weatherby (Rhodora 1916), enumerating eleven species as indigenous to eastern North America south of Hudson straits.

However, in giving *Puccinellia* preference to *Atropis* Fernald and Weatherby have certainly misunderstood Ruprecht, because this author has clearly demonstrated that he considered *Atropis* and some other genera as being distinct from *Poa*. And when Ruprecht states that: "E conditione glumarum generum series fortasse sequens: *Dupontia, Arctophila, Poa, Atropis* cet," this author did not mean that these: "from the condition of the glumes perhaps represent a series of genera as follows: *Dupontia* cet.," but that the genera mentioned might be arranged according to the structure of the glumes, as enumerated above; series means in this connection sequence referring to the arrangement. Moreover, it seems unjust to ignore *Atropis* because the diagnosis of *Puccinellia* by Parlatore is more complete; if such procedure be considered "the best for serving the cause of sound nomenclature," as claimed by these authors, very many genera of Linnaeus would suffer the same fate.

By comparing the species of *Gly-* the classification proposed by Fries (l.c.) appears the most natural, retaining the genus intact, as has been proposed also by Duval-Jouve in his classic treatise: Doutes et prières au sujet de quelques espèces de *Glyceria* du groupe des *Halophiles*.[6]

[1] Fedde's Repert, l.c.
[2] Florae Samojed. Cisaral. 1846.
[3] Fl. Ital. I. 1848.
[4] Summa veget. 1846.
[5] Flora d. nordwestdeutsch. Tiefebene. 1894.
[6] Bull. Soc. Bot. France; Paris. 1863.

The species enumerated in the following pages represent a certain type of the genus, and the only one known from the arctic regions which by some authors has been considered worthy of generic rank, distinct from *Glyceria* sensu strictiori. As a section of *Glyceria* this type was described already by Elias Fries[1] under *Heleochloae*, while most of the other species were referred to the section *Glyceriae genuinae* Kunth. According to Fries the principal characters of the latter were "Stylus distinctus, pilis stigmatis denticulatis. Valvula exterior septemnervis, nervis elevatis, etc." In the *Heleochloae* the characterization reads: "Stigmata subsessilia, simpliciter plumosa. Valvula exterior 5-nervis, nervis obsoletis. *Festucae* spec. Kunth."

Very brief and incomplete is the diagnosis by Hackel,[2] namely: "*Glyceria*, styles distinct, lodicules grown together; and *Atropis*, styles none, lodicules distinct."

Glyceria vilfoidea (Ands.) Th. Fries (Fig. A: 4-5). This well-known and, on the arctic shores, so very frequent species has recently been transferred from one species to another or reduced to a mere variety. By Scribner and Merrill it is considered identical with Trinius' *Poa phryganodes* (l.c.) and has suffered a similar fate in the hands of Fernald and Weatherby (l.c.). It would, however, seem very strange if the earlier authors familiar with the species described by Trinius had not discovered that Anderson's *Catabrosa vilfoidea* was identical with it. Trautvetter,[3] for instance, does not cite the species of Trinius as a synonym of *Glyceria vilfoidea* (Ands.); neither do Kjellman and Lundström in their extensive writings on arctic botany, nor Lange in his Conspectus (l.c.). As long as we feel sure, and indeed unquestionably so, about the identity of *Glyceria vilfoidea* but not of the other plant, it would naturally be more safe to retain this name, even if it be of a younger date than *Poa phryganodes*. Dr. Trimen laid down a very good canon about names in botany, viz.: to take the most certain name, even if it be of a younger date; for nothing works so badly as to take an uncertain name; it is disputed, and we may have several names running at once. In recent years works dealing with enumerations of plants from various countries are actually filled with new combinations because the authors believe that they have detected a much older name than the one now in use; very many of these old names, however, are so uncertain that the earlier writers discarded them, and the result is, of course, the introduction of an older name, which is supposed to be correct, until still another be proposed, thus involving an immense amount of new combinations. Examples of this kind abound in recent works; we need only mention the much disputed *Poa triflora* Gilib., *Carex fusca* All., *C. Halleri* Gunn., etc., names that were never accepted by the earlier writers on systematic botany. And as long as the old masters discarded such names, they surely must have had some reason for doing so; in any case the earlier writers, I mean Trautvetter, Blytt, Hartman, Fries, Lange, Wahlenberg, for instance, were certainly more familiar with the writings of Gilibert, Allioni, and Gunner, for instance, than authors of to-day.

Recently *G. vilfoidea* has also been referred to *G. maritima* as a variety, respectively to "*Atropis*" or "*Puccinellia*," thus involving "new combinations."

Meanwhile Krok[4] claims that *G. vilfoidea* was actually discovered in the year 1838 by Laestadius in Finmarken, and that he called it *G. distans* var. *reptans* Laest., but without publishing the diagnosis. The fact that the plant became described by Hartman[5] several years before Anderson described his *Catabrosa vilfoidea*, induced Krok to suggest the name *G. vilfoidea* to be changed to *G. reptans* (Laest.). However, since the name *G. vilfoidea* is the one used by the leading authors on arctic botany, and since we know the species with absolute certainty, the name "*vilfoidea*" proposed by Anderson ought to be retained.

[1] Novit. Florae Suecicae. Mant. II, 1839.
[2] in Engler's: Die nat. Pflanzenf.
[3] Incrementa Florae Phanerogamae Rossicae. Fasc. IV. Petropolis, 1884, p. 850.
[4] Tvänne i Finmarken återfunna fanerogamer (Bot. Notis. Lund, 1899, p. 137).
[5] Excursions Flora Ed. I. 1846.

To consider the species as a mere variety of *G. maritima*, as has been done in recent years, is open to question, and Johanson [1] has written a very instructive paper, demonstrating that *G. vilfoidea* and *G. maritima* are not conspecific.

Lange gives a good diagnosis of *G. vilfoidea* (Conspectus l.c. p. 170) as follows:

"Gracilis, glaberrima, rhizomate obliquo, foliorum fasciculos-abbreviatos et flagella valde elongata gracilia emittente; foliis anguste linearibus subcomplicatis, acutis; ligula brevi, truncata; panicula brevi, contracta, ramis sub anthesi adpressis, defloratis erecto-patentibus, inferioribus subgeminis, super. solitariis; glumis obtusis inaequalibus flosculis 2-3, palea inf. ovali, obtusa, 3-5-nervia."

"Obs. Species haec, non nisi e Groenlandia et ins. Spidsberg. hucusque cognita, modo crescendi aliisque characteribus a *G. maritima* recedit, etsi hujus formis quibusdam (*G. maritima* var. *arenaria* E. Fries Mant. 2. p. 9) affinis est."

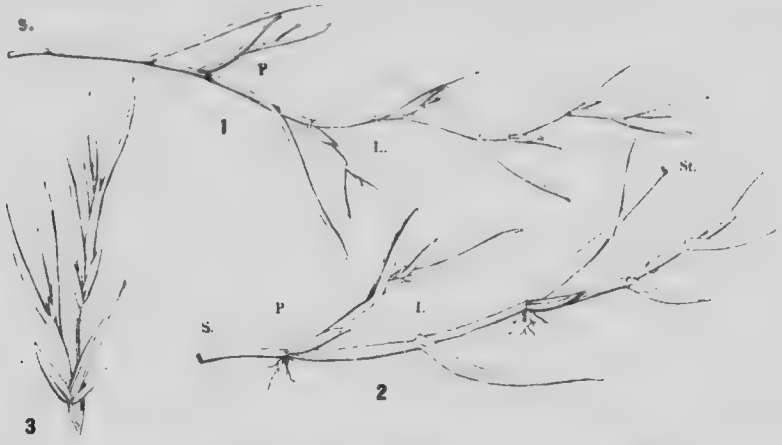

FIGURE B.

1. Stolon of *Glyceria vilfoidea* (Ands.) Th. Fr.; P = the prophyllon (fore-leaf); L = lateral shoot; S = primary shoot; natural size. (St. Paul island, Bering strait.) 2. Stolon of *Catabrosa aquatica* (L.) Beauv.; St = flower-bearing stem; other letters as above; natural size. (Sweden). 3. Two viviparous spikelets of *Aira alpina* L.; magnification 1¾ (Greenland).

For a comparison I have drawn the spikelets of both (Fig. A: 4-5 and 6-7).

Moreover, as pointed out by Johanson (l.c.), the structure of the stolons differs in a marked degree from that of the other species of *Glyceria*, and seems indeed to be rare, or at least but little known from Gramineae in general. The accompanying text figure (B) shows part of a stolon of *G. vilfoidea* (fig. 1); in this the main shoot is aerial (S), and bears several green leaves, separated from each other by stretched internodes; at each node a small lateral shoot is developed (L), of which the first leaf represents an adorsed prophyllon (P) or fore-leaf, as is the usual structure of lateral shoots in the monocotyledons. But, as may be seen from the drawing, the lateral shoot is not situated in the axil of the corresponding stem-leaf, but has been moved up to the node above, thus occupying a very strange position remote from the leaf-axil. It is a structure that recurs in the genus *Catabrosa*, for instance, in *C. aquatica* (L.) Beauv., where the structure is very plainly visible (fig. 2); in this plant the stolons appear to root more freely, the secondary roots proceeding from the nodi, as shown in the drawing.

The fact that *G. vilfoidea* seldom produces flowers, and that fruiting specimens are almost unknown, indicates that vegetative reproduction supersedes the floral, and in this respect *G. vilfoidea* is readily distinguished from the other species of the genus. While vegetative reproduction is known to be prevalent

[1] Om Glyceria maritima (Huds.) Wahlenb. var. arenaria och Glyceria vilfoidea (Ands.) Th. Fr. (Sv. Bot. Tidskr. 4. Stockholm, 1910).

in several other plants, notably arctic and alpine, the organs of reproduction in these are flowers transformed into small shoots or bulblets, instead of being stolons developed from the basal leaves. In *Aira alpina*, for instance (fig. 3), the spikelets are transformed into leafy shoots, since the flowering glume, the palet, and the sexual organs have developed in the shape of green leaves with sheaths and blades, while the empty glumes show the typical structure of glumes. A similar transformation of flowers into leafy shoots is known also from the arctic-alpine *Polygonum viviparum*, from some of the Saxifragae, *S. cernua* and *S. stellaris*, where most of the flowers develop in the shape of bulblets, but the almost total absence of flowers and the vegetative reproduction being effected by means of true stolons seems to be especially characteristic of *Glyceria vilfoidea*.

G. tenella Lge. and **G. vaginata** Lge. were also collected on the expedition and since the former has been so very poorly described in Ostenfeld's Flora Arctica, and the latter having been merged into *G. distans* (L.) Wahlenb. by this same author, I deem it necessary to insert the original diagnoses of these, and of some other arctic Glyceriae, which may prove useful to future students of arctic plants. Some of the species have been illustrated with respect to the structure of the spikelets in the text-figures.

Glyceria tenella Lge. (Fig. A: 10-13) is described in Kjellman and Lundström's Fanerogamer från Novaja Semlja: "*Gl.* caespitoso-pulvinata, multicaulis, caulibus gracilibus circa 3" longis, adscendentibus (v. prostratis?); foliis angustissime linearibus, complicatis, obtuse et oblique mucronatis; ligula brevissima, truncata; panicula brevi, laxa, racemiformi, contracta, florendi tempore e vagina folii caulini superioris vix exserta, ramis laevibus 1-2 in verticillis, inaequilongis; spiculis glabris, circa 3-floris, floribus invicem remotis; glumis obtusiusculis, superiore subduplo longiore; palea inferiore violacea vel viridi, anguste albomarginata, obtusa vel subtruncata, leviter erosa, 3-5 nervi; antheris pallide fuscis vel sordide luteis; ovario elliptico-ovali, stylis invicem subdistantibus terminato. Hab. In sinu Rogatschew insularum Novaja-Semlja et ad promontorium Grebeni insulae Wajgatsch legerunt F. R. Kjellman et A. N. Lundstroem mense Julii 1875.

"Habitu nec non pluribus characteribus a reliquis *Glyceriis* mihi notis distincta, maxime ad *Gl. vaginatam* Lge. et *Gl. distantis* var. *pulvinatam* accedens, cum nullis harum tamen associanda."

G. tenella Lge. forma **pumila** Lge. (in Holm: Novaia Zemlia's Vegetation).

"Differt a typo in insulis Novaia Zemlia a cl. Kjellman et Lundstroem lecto: statura pumila, culmis vix ultra 1" longis, panicula (racemo brevi) florendi tempore extra folium sup. exserta; palea inf. magis obsolete nervata. Forsan *G. tenella* ipsa (hac forma inclusa) ad *G. vaginatam* Lge. e Groenlandia (Fl. Dan. T. 2583) ut forma reducta trahenda est, sed haec panicula magis effusa et ramosa, spiculis 5-6 floris gluma inf. latiore differt.

Hab. in rupibus insulae Novaia Zemlia ad Petuchowskoj Schar.

Glyceria vaginata Lge. (Consp. Fl. Groenl.) (Fig. A: 18).

"Dense caespitosa; culmo ad basin 1-2 nodis geniculato, articulo superiore elongato, fere ad paniculam usque vagina ampla, folii lamina multo longiore incluso; foliis mollibus, anguste linearibus, laevissimis, glaucis, planis vel siccatione involutis, ligula brevi, obtusa; panicula laxa, ramis subgeminis, capillaribus, ante et post anthesin erectis; spiculis laxe 5-6-floris, glumis ovatis, obtusis, inferiore duplo breviore, palea inf. concava, obtusissima, obsolete 5-nervia, basi pilosiuscula, super. paulo longiore, truncata, apice eroso-ciliata." Known so far only from the coast of West Greenland.

Glyceria? Kjellmanni Lge. (Fig. A: 21-26.) (in Kjellman & Lundström: Fanerog. fr. Novaja Semlja).

"*Gl.* perennis, caespitosa, multiceps; fasciculis singulis caespitis polyphyllis; foliis inferioribus ad vaginas reductis, foliis caulinis 1-2, omnibus planis, laxiusculis, e basi lata sensim angustioribus et oblique acuminatis, ligula protracta, acutiuscula, leviterque denticulata; culmis erectis vel geniculato adscendentibus, 2-5 longis; panicula e folio caulino supremo longe exserta, brevi, angusta et coarctata, ramis 1-2, brevibus, erectis cum rhachi laevibus et glaberrimis; spiculis circa 2: floris; glumis ovatis, inferiore pellucida, 1: nervi, superiore $\frac{1}{3}$ longiore, 3: nervi et circa nervos violaceo-tincta, margine pellucida lacera; palea inferiore ovato-lanceolata, nervis 3, latis, violaceis $\frac{3}{4}$ longitudinis parte percursa, basim versus dorso et margine dense pilosa, apice irregulariter denticulato-lacera, palea superiore margine revoluta ad nervos 2 pilis albis, rigidis ciliata apice summo denticulata; antheris pallide fuscis vel sordide luteis; ovario elliptico stylis 2, invicem approximatis terminato.

"Hab. In insulis Novaja Zemlja ad fretum Matotschkin legerunt Kjellman et Lundstroem, 7-13 Julii 1875.

"Habitum *Glyceriarum* minus bene exprimit et obiter inspecta potius *Pois* quibusdam similis, sed characteribus, imprimis glumis dorso teretibus a *Poae* genere recedit, nec reliquae characteres obstant, quin ad *Glyceriae* genus referri possit, nisi quod spiculae fere semper bi-florae et paleae dense villosae, superior immo margine rigide ciliata (fere ut in *Bromo*). Habitu *Dupontiis* haud dissimilis est, sed hoc genus glumis spicula aequilongis praeter plura abunde recedit. Itaque hoc gramen singulare ad interim *Glyceriae* generi subsumsi, nisi forte proprium genus constitueret."

Glyceria Vahliana (Liebm.) Th. Fries. (Fig. A: 8-9).

"*Poa Vahliana* (Liebm.): gramen caespitosum spithamaeum, radice fibrosa, culmo 3-foliato, vagina superiore folio 1½ pollicari longiore, ligula producta oblique truncata; panicula contractiuscula radiis binis solitariisque, spiculis subtrifloris pedicellis longioribus vel aequilongis; glumis subaequalibus-elongato-lanceolatis obtusiusculis glabris obsolete-nervosis, basi apophysi parva instructis; paleis glumas, superantibus valvulis inaequilongis, exteriore lineari-lanceolata obtusiuscula obsolete 5 nervia, nervis pilosulis, interiore breviore apice bidentata nervis 2 marginalibus purpureis ciliatis percursa, lodiculis oblique bidentatis, germine elliptico obtuso, stigmatibus 2 plumosis." Flora Danica, 41, tab. 2401; Kjoebenhavn, 1845.

The species was found by Vahl on the west coast of Greenland, by Niakornak near Umanak, at an elevation of about 700 M.

Lange (Conspectus Fl. Groenl.) adds to the diagnosis: "foliis flaccidis, planis, acutissimis; glumis parum inaequalibus, purpurascentibus, margine apicem versus albomarginatis."

Glyceria Langeana Berlin (Kärlväxt., insaml. under svenska expeditionen till Grönland 1883).

"Humilis, dense caespitosa; foliorum fasciculis intravaginalibus; foliis rigidiusculis arcuatis; culmis rigidiusculis vix folia superantibus; paniculis et spiculis glabris; glumis inaequalibus acutiusculis; paleis obtusis exterioribus apice laceratis."

North Greenland: Kangaitsak.

Glyceria angustata (R. Br. sub *Poa*) Fr.[1] (Fig. A: 14-15).

By Robert Brown (Chloris Melvilliana, p. 223) the species is described as follows:

"*Poa angustata*, panicula simplici coarctata lineari-lanceolata, locustis 4-5 floris, gluma inferiore dimidio minore, perianthiis apice erosis: valvula inferiore basi elanata lateribus glabriusculis, foliis angusto-linearibus.

"Desc. Gramen 4-6-unciale, glabrum, erectum; radice fibrosa. Culmi foliati, basi quandoque divisi, laeves. Folia angusto-linearia, plana, acuta, glabra, laevia; vaginae subcylindraceae, laeves, suprema folio proprio longior,

[1] Novit. Fl. Suec. 3. Mantissa Lund, 1842.

omnes ipsa basi integra; ligula subquadrata [illegible]n lata quam longa, apice dentata dente medio paulo longiore. Panicula erecta, angustata, circumscriptione lineari-lanceolata, ramis paucifloris, pedicellis denticulatis, strictis, viridibus, apice paulo dilatato, cum locusta haud omnino continuo. Locustae hyalinae, glaberrimae, uninerviae, cum pedicellis persistentes, valvula inferiore fere dimidio minore; superiore duplo latiore et fere duplo longiore, obtusiore, perianthio dimidio circiter breviore, nervis lateralibus obsoletis. Perianthia separatim decidentia, rachi locustae glabra; valvula inferior oblonga, concava, acutiuscula, apice scarioso eroso-denticulato, quinquenervis, lateribus infra medium pube rara in nervis extimis crebriore instructis, ipsa basi absque lana implexa; superior paulo brevior, dinervis, nervis viridibus, denticulatis, lateribus complicatis. Lodiculae 2, hyalinae, imberbes, semibifidae. Stamina 3."

According to Lange the species is a near ally of *G. Vahliana*.

Glyceria paupercula Holm (in Fedde, Repert. III, 1907) (Fig. A: 16-17).

"Caespitose, perennial: culms low, curved or decumbent, mostly leafy to the panicle, the base of which is often enclosed in the leaf-sheath; leaves narrow, flat, glabrous, the blade about as long as the sheath; panicle pyramidal and open during anthesis, more or less contracted afterwards; spikelets three to four-flowered, seldom five-flowered; empty glumes unequal, the lower the shorter, both much shorter than the spikelets; flowering glume pointed, carinate, glabrous, five-nerved; palea bidentate, glabrous.

"It is a member of the section *Atropis* Rupr.

"Mansfield island, Hudson bay; collected by Dr. R. Bell."

Since I described this species a revision of the genus *Puccinellia* in eastern North America has been presented by Fernald and Weatherby, in which several new stations have been recorded from the coasts of Labrador, Keewatin, Newfoundland and Quebec, besides that two varieties have been described by these authors: *alaskana* (Scribn. et Merrill), new comb., and *longiglumis* n. var., the latter from Prince Edward island.

According to the revision, cited above, the var. *alaskana* has been passing very generally in eastern America as *Puccinellia angustata*, based upon *Poa angustata* R. Br., as for instance, by Simmons (Vascular plants, Ellesmereland, 1906), whose specimens thus belong to the variety of *paupercula*.

Glyceria arctica Hook. (Fl. Bor. Am. II, p. 248.) (Fig. C.).

FIGURE C.—*Glyceria arctica* Hook. (Greenland).
1. Spikelet. 2. Empty glumes. 3. Flowering glume, side-view. 4. Same, dorsal view. 5. Palea.
(All figures enlarged.)

Lange (Consp. Fl. Groenl. l.c.) describes this as follows:

"Caespitosa, 1-1½' longa, culmis e basi geniculato adscendentibus v. erectis, rigidis (v. rarius laxiusculis); foliis planis, exsiccando involutis; paniculo ampla (ad 6" longa), rachi inflorescentiae scabro, ramis firmis, erecto-patulis (raro divaricatis), ante et post anthesin adpressis; spiculis majusculis 5-8-floris, glumis acutiusculis, infer. duplo breviore; palea inf. 3-5-nervia, obtusa, apice eroso-denticulata.

"Var:

"β *laxa* nob. (*G. arctica* Hook. ex descriptione) Dur. pl. Kan. No. 97 (ex loco natali) foliis latioribus, planis, flaccidis, pagina superiore scabris; paniculae ramis infer. 2-3 in verticillis, post anthesin divaricato-reflexis, spiculis variegatis, 6-8-floris.

"γ *capillaris* nob., culmis flaccidis; foliis elongatis, angustis, supra laevibus; panicula nutante, ramis longiusculis, capillaceis, flexuosis 2-3 in verticillis, defloratis erecto-patulis, inferne longo spatio nudis, spiculis laxe 5-6-floris, viridibus.

"δ *dasyantha* nob., rigidiuscula, praecedentibus humilior, palea inf. e basi ad medium dorso lateribusque pubescente, basi, (*Poarum* instar) longe lanata.

"Species polymorpha, praecedenti (*G. marit.*) affinis et forsan non nisi ejusdem varietas, tamen modo crescendi, statura elatiore et pluribus characteribus videtur distinguenda. Nomen *G. arcticae* Hook. adhibui, cum descriptio (l.c. p. 248) satis bene nostrae plantae respondeat; observari tamen debet figuram (Bor. Am. tab. 229) evidenter ad specimen macrum et nondum plene evolutum factam esse. Suppositionem (in textu ad Fl. Dan. 2582), plantam groenlandicam eandem esse cum *G. maritima* v. *palustri* Fr. adhuc bene fundatam esse censeo."

Greenland.

Elymus mollis Trin.

This species is frequently confounded with the arctic *E. arenarius* L.var. *villosus* R. Mey. By Grisebach (Fl. Ross. l.c.) *E. mollis* is described as follows: "Culmo apice velutino, foliis demum convolutis, spica elongata, spiculis geminis v. ternis 5-plurifloris rhacheos internodium superantibus, glumis late lanceolatis acuminatis 5-7-nervibus margine membranaceis floribusque dense villosis, his exsertis, nervis tenuibus dorso prominulis." The variety *villosus* of *E. arenarius* is described by Lange (l.c.): "Humilior quam forma in Europa vulgaris, sed spica robustior, glumis dense villosis; ceterum vix a type differt."

CYPERACEAE.

Carex [Ruppius] L.

The genus is poorly represented on the arctic coast explored by the expedition and *C. incurva* is the only *Vignea* collected. With regard to the habit the stoloniferous species are more frequent than the caespitose, and they all are "*phyllopodae.*" This character "*phyllopoda*" implies a biologic peculiarity which is possessed especially by northern types; it consists in the shoot being dicyclic, i.e. vegetative in the first, floral in the second season, with the ramification of the shoot sympodial. Moreover, in this type the very young inflorescense is protected by being surrounded and covered by a number of leaf-sheaths. The inflorescence thus terminates the shoot and when the fruits have matured, the main shoot dies off completely while a lateral bud developed in the axil of one of the basal leaves continues the growth of the rhizome and repeats the succession of a vegetative and floral stage. Otherwise with the "*aphyllopodae.*" In these, principally southern species, the shoot is most often plicycelic with reference to the vegetative stage but monocyclic as far as concerns the floral. For in the *aphyllopodae* the ramification of the shoot is most frequently monopodial; however, there are some species which, although being *aphyllopodae,* show a sympodial ramification and in which the very condensed rhizome, mostly more or less caespitose, develops a number of purely floral and purely vegetative

shoots but with no apparent regular succession. Characteristic of the *aphyllopodae* is, however, that the young inflorescence is not covered by leaf-sheaths from the year previous but by scale-like leaves or, let us say, "bud-scales" developed at the same time as the bud appears. These types: *phyllopodae* and *aphyllopodae*, were first brought to attention by Elias Fries [1] and they are indeed very characteristic and helpful to the determination of many critical species. In my papers dealing with Cyperaceae [2] I have often demonstrated the distinction of these types as an important means of classifying *Carices*.

With regard to the species, the list shows that the *Vigneae* are only represented by *C. incurva*, while eleven *Carices genuinae* were collected. As has been the experience of other arctic expeditions, the *Microrhynchae*, *Aeorastachyae* and *Physocarpae* are the most frequent, and *C. stans* Drej. seems to be the most common; it represents *C. aquatilis* Wahlenb. of the more southern, but still boreal, regions. Since *C. stans* has sometimes been mistaken for tall specimens of *C. rigida*, I have figured one of the specimens from Herschel island (Part A, Plate I, figs. 1-4), beside a much larger one, which I collected on the west coast of Greenland, near Jacobshavn (Part A, Plate I, figs. 5-8).

The original diagnosis [3] reads as follows:

"Spica mascula 1, feminis 3-6, elongatis cylindricis densifloris obtusis subsessilibus, bracteis infimis foliaceis latis planis culmum superantibus auriculatis, squamis oblongis obtusis, perigyniis (immaturis) obovatis brevissime rostellatis ore integris enerviis, stigmatibus 2-3.

"Groenland; Vahl.

"Radix stolonifera crassa vaginis obducta. Culmus erectus, strictus, crassus, obtusangulus v. acutangulus, laevissimus v. (raro) superne scabriusculus. Folia plana, lata, laevissima v. apicem versus margine scabrata. Spicae 4-8, terminalis mascula, reliquae femineae, mascula cylindrica subclavata squamis oblongis obtusis, femineae densiflorae obt[illegible], superior interdum apice mascula, infima pedunculata reliquae sessiles. Bractea infima longissima culmum superans, marginibus apicem versus scabris, auriculis brevissimis subamplectentibus. Squamae perigynio multo minores, obtusae, fuscae v. nigrae, v. perigynia superantes acutiusculae. Perigynia obovata enervia, estipitata brevissime rostellata ore integro, viridiflavae v. apice fuscae. Stylus brevis subexsertus, stigm. 2 v. 3 elongata, flaccida villosula.

"Haec species, cujus perigynia modo immatura vidi, ex distylis *C. aquatili* et *C. saxatili* maxime affinis est. Ab illa differt foliis omnino planis latis, bracteis brevioribus, spica mascula solitaria, colore spicarum fusco v. [illegible]ato, statura humiliore. Ab hac: bracteis latis planis brevissime auriculatis c[illegible]mum multo superantibus, spicis subclavatis densifloris cet. A ceteris distylis longius distat: *C. acuta* differt spicis pedunculatis pendulis acutis; *C. caespitosa* spicis acutis, bracteis angustioribus, culmo scaberrimo, perigyniis stipitatis nervatis. *C. stricta* Good. spicis magis laxifloris acutis vaginis foliorum fibrilloso-reticulatis, cet."

This diagnosis was based upon specimens collected by Vahl in Greenland.

Kükenthal [4] refers *C. stans* to *C. aquatilis* as a variety including *C. variabilis* Bail., a species from the subalpine bogs in the Rocky mountains (Canada-Colorado); however, this classification is not natural, and is undoubtedly the result of working with too scant material.

Concerning *C. subspathacea* and *C. reducta*, these are near allies of *C. salina*, but their geographical distribution is much farther north; they have been described and figured in a recently published paper, dealing with *Carices aeorastachyae*: *Salinae*.[5]

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[1] Synopsis Caricum distigmaticarum, spicis sexu distinctis, in Scandinavia lectarum. Bot. Notiser. Lund. 1843, p. 97.

[2] Am. Journ. of Science, Vol. 48. New Haven, 1919, p. 19.

[3] Drejer, S. Revisio critica Caricum borealium. Naturhist. Tidsskr. Vol. 3. Copenhagen, 1841.

[4] Cyperaceae-Caricoideae in Engler: Das Pflanzenreich. Leipzig, 1909.

[5] Holm, Theo. Studies in the Cyperaceae. Am. Journ. of Sc., Vol. 49. New Haven, 1920.

LILIACEAE.

Bulbous plants are extremely rare in the arctic region. *Zygadenus glaucus* Nutt. of the Melanthaceae, *Lloydia serotina* and *Allium schoenoprasum* of the Liliaceae are, so far as I know, the only bulbous species known from this region; they were collected by Kjellman at Port Clarence, while *Lloydia* is the only one collected by the expedition.

The genus *Lloydia* has an interesting history and we owe to Irmisch [1] an excellent account of the history and of the morphological structure of the species. It was first described by Caspar Bauhin,[2] who named it *Pseudonarcissus graminea folio, sive Leucanarcissus aestivus;* at that time it was known only from the mountains of Switzerland and Austria; several years afterwards it was collected also in England, on the highest peaks of Snowdon in Wales by Ed. Lhwyd (also written Lloyd), and by Rajus designated with the uncertain appellation as: Bulbosa alpina juncifolia, pericarpio unico erecto in summo caulículo dodrantali. Rajus, as a matter of fact, had only fruiting specimens. By Dillenius it was named *Bulbocodium alpinum;* by Linnaeus *Bulbocodium serotinum* and later on *Anthericum serotinum*, until Salisbury referred it to a new genus which he named *Lloydia*.

SALICACEAE.

Salix Richardsonii Hook.

The accompanying photograph (1) shows a tree of this species from Mackenzie river, south coast of Victoria island.

Photograph (2) shows the same species, growing along a small tributary to Coppermine river (below Bloody fall).

About the occurrence of this species in the river-bed of Sadlerochit river Alaska, Mr. Johansen quotes from his field-notes as follows:

"Two species of willow-shrubs and trees seem to occur in this river-bed and on the sheltered and wet places (tributary creeks) of the adjoining mountain slopes, about 25 miles from the coast: (1) A very common and dominant species (*Salix Richardsonii* Hk.) with reddish bark (branches) and pubescent twigs and leaves, the latter being rather broad and ovate-shaped; in favourable places this willow attains more than man-height and a trunk thickness of up to about 6 inches in diameter and forms a dense tree or shrub growth. (2) A not nearly so common species (*S. glauca* L.) with more narrow leaves, and less pubescent twigs and darker bark. It does not attain (in these arctic river-beds) the size of (1), is hardly more than a shrub and has a far less twisted-forked appearance, but a more straight growth than (1). Also it seems to prefer more dry places than (1) and is first met with some distance from the coast inland.

"Willows about man-height were seen on the low, gravelly clay banks or islands in the bed of the river at its mouth; but outside of these (and similar) protected places it was only in the larger creek-valleys that they attained a similar or bigger size. Such a creek valley, bordered by 200-300 feet high clay banks on the east side of the river I went into. The clay banks had the usual tundra vegetation (including dwarfed willows) on top, and steep bare sides; but in the creek bottom willows had an extensive and luxurious growth (getting scarcer and dwarfed at the head of the creek), attaining more than double man-height and trunks thicker than a man's arm on specially protected places. (See Neg. 2).

"There seemed to be two species, the one (*S. Richardsonii* Hk.) reaching a far greater size and being much more dominant than the other (*S. glauca?*). Similar conditions for and occurrences of willows were reported by different members of the expedition from other rivers (Tree and Hood rivers) flowing into Coronation gulf."

[1] Beiträge zur vergleichenden Morphologie der Pflanzen. Bot. Zeitung, Leipzig, 1863, p. 161.
[2] Prodromus. Basel, 1671, p. 27.

Salix Richardsonii Hook.

A tree in creek-bed of Rae's "Mackenzie River," south coast of Victoria Island about 111° 30′ West. March 29, 1916. (Photo by F. Johansen.)

S. anglorum Cham.

The species was collected at several stations and, with regard to its occurrence, Mr. Johansen writes:

"*Cape Bathurst.* Grows among grasses, etc., on the clay-banks with which the higher tundra behind falls off to the sandspit, and on the tundra itself. Found both on the top and slopes of these clay-banks; in the former place the vegetation is more stunted and scarcer than on the slopes and in the protected, small gullies here. Growth somewhat prostrate and spreading, but twigs and catkins protruding well from surrounding vegetation."

Salix Richardsonii Hook.

From tributary to Coppermine river (below Bloody Fall). February 10, 1915. (Photo by E. Johansen.)

"*Pihumalerksiak island*, Dolphin and Union Strait, N.W.T. [off Cockburn point - R.M.A.]. The vegetation of this island is rather scarce and stunted owing to its exposed position and poor soil (dolomite-rock or gravel); it is best developed in depressions, or in shelter of protruding cliff-parties or large boulders. The conditions and the vegetation are thus similar to those found on the island (except Chantry island) in the outer harbour at Bernard harbour.

"The willows in question grew in patches here and there; generally several plants together; growth prostrate, and each plant not nearly as spreading as on the mainland.

"*Bernard harbour* (mainland), Dolphin and Union strait. Very common everywhere, especially on poorer soil (sand, gravel), where it is one of the dominating plants. On such gravelly and sandy soil with little other vegetation and where more exposed the plant spreads out over the ground (not half buried in the sand as is the case with *S. oralifolia*) in all directions, the whole plant reminding one of a huge basket-starfish. The centre of the plant is elevated most (thick trunk-bases, many dead leaves); and most of the leaves and catkins are found at the terminal branch-ends, which seem to seek out small depressions in the ground to shelter the twigs. The diameter of a very large plant may reach a couple of yards; its height over the ground only a few inches. As is the case with other prostrate willows the female catkins are less likely to be blown off the plants during the winter, where these latter (not the catkins) are snow-covered. In 1916 the season was several weeks earlier than in 1915, and the catkin-buds were noticed to emerge from their bracts in the end of May, 1916; though it took a whole month before the first flowers appeared. In 1915 the first staminate flowers were noticed June 23 and the first pistillate ones (and new leaves) five days later. The flowering begins earlier at the coast and on island than farther inland. The flowers in the catkins have the following colours: (1) staminate scales (bractlets) black with purple base and white hairs; small inner scale (bractlet) purple; filament pale-pink; anthers dark rose-purple, turning yellow when the pollen came out, later black. (2) pistillate: As the staminate (capsules) dark purple, below with white woolly hairs." .

S. ovalifolia Trautv. var. **camdensis** Schn.

About this Mr. Johansen writes as follows:

"*Collinson point* (Camden bay). This willow grew on more bare, gravelly tundra near the beach (transition-region to the latter), in patches of several plants. Its growth was very prostrate and depressed (among stones and vegetation) with the stems and branches lying very close to the ground and spreading widely, so that only the catkins showed up from a little distance. Especially the subterranean parts (roots and stem parts) were less extensive and spreading than with those found at Konganevik, Alaska (see below); probably because they did not grow on sand dunes as is the case at the former place.

"*Konganevik* (Camden bay). The collecting place was where the seashore (beach) through low sand dunes goes over into the more typical tundra behind. On these sand dunes the vegetation is very characteristic and consists almost exclusively of *Elymus, Carex, Salix, Chamaenerium*, etc.; each species spreading (both above and under the ground) over large patches (areas) and dominating more or less to the exclusion of the other species. This *Salix* seemed to be very prostrate, but the larger part of each plant is buried in the sand, so that only the leaf- and catkin-carrying branch-parts (outer $\frac{1}{3}$) protruded. It was mostly large plants widely spreading (both roots and stems); the branches often having form of long "runners" intersecting the sand in all directions. The sand-covered parts of the branches were without leaves or catkins and pale (white-yellow). When growing in less sandy soil the growth is naturally more condensed (see above under Collinson point). The plants were in full bloom in the end of June here.

"*Martin point.* The collecting place was a sandy gravel spit of slight elevation with the sand dunes less pronounced than at Konganevik. Vegetation rather scattered and in patches except around the several ponds and the big lagoon between the sand spit and the mainland behind. On sandy places the vegetation was much like that at Konganevik, with *Honckenyia* taking the place of *Chamaenerium*. As the character of the spit was somewhat intermediate between the beach regions at Collinson point and at Konganevik, so did also the growth of the *Salix* in question resemble those of the species from both of the above places. At the time of collecting the plants had dropped staminate catkins and had unripe pistillate."

S. reticulata L.

As may be seen from the text-figure (D) the foliage varies quite considerably as to size and shape; in nearly all the staminate plants collected the leaves were smaller than in the pistillate. The large, almost orbicular leaf (Fig. 1) is from a large pistillate plant of which all the leaves showed the same outline and approximately the same size; the two leaves (Figs. 2 and 3) are from a staminate plant and both forms of leaves occurred together on this plant; the specimens were collected at Bernard harbour.

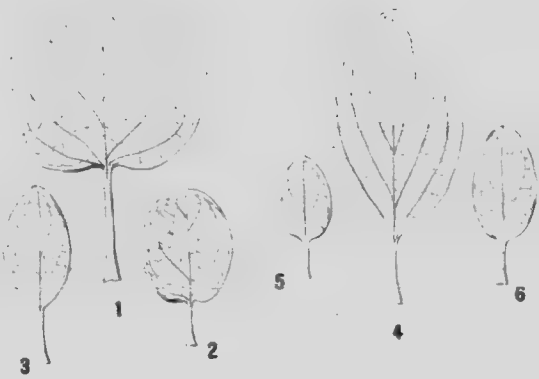

FIGURE D.
Leaves of *Salix reticulata* L.

1. Pistillate plant; Bernard harbour. 2. Staminate plant; same locality. 3. Staminate plant; same locality. 4. Pistillate plant; Herschel island. 5 and 6. Pistillate plant; Bernard harbour. (All leaves show the natural size.)

POLYGONACEAE.

Polygonum viviparum L.

Some tall specimens from Camden bay measure in height 16 cm. The subterranean stem is a short, but thick, horizontal rhizome with the internodes extremely short; towards the apex the rhizome is more or less bent so as to form a knee; no stolons are developed, and thin, secondary roots proceed from the rhizome. Characteristic of the species is the development of bulblets in the inflorescence; they have been described by Areschoug.[1] These bulblets consist of a tuberous axis of two internodes, and the leaves are membranaceous, sheathing; at the apex of the bulblet is a terminal bud enclosed within membranaceous leaves, mostly three. When the bulblet falls off a green leaf appears and secondary roots develop from the tuberous internode. These bulblets thus form new individuals and constitute an important means for distributing the plant over a larger area since, as mentioned above, there are no stolons.

P. Bistorta L.

Hjalmar Nilsson[2] has described the structure of the rhizome which according to this author represents a monopodium with a terminal, vegetative bud, and with the flower-bearing stem developed in the axil of one of the green leaves. The rhizome resembles that of the preceding species but it is stoloniferous and, on the other hand, no bulblets are developed in the inflorescence. The specimens collected measured a height of about 18 cm., including the inflorescence with the flowers well developed.

Rumex arcticus Trautv.

Several specimens were collected with flowers and mature fruit; the height of a fruiting specimen from Bathurst inlet measured 40 cm., the stem being 12 cm., while the large inflorescence was 28 cm. The subterranean stem represents a very condensed pseudo-rhizome borne upon a deep, thick tap-root; beside that, long and quite thick secondary roots develop from the subterranean internodes. Green leaves are quite numerous, forming a rosette.

Oxyria digyna (L.) Hill.

In this plant the aerial shoot represents a rosette of leaves with the flower-bearing stems apparently lateral. With respect to the subterranean organs there is a deep but relatively slender primary root which persists for several years; from the crown of the root several erect or ascending stems are developed; they are densely covered with remnants of leaves and the internodes are very short. From these subterranean stem-portions stolons develop (Fig. E); they are covered with tubular leaves but the internodes are often quite distinct, and secondary roots proceed from the nodi. The specimen figured represents a case of the aerial shoot being developed from a stolon, beside that a young stolon of second order has developed from the ascending, subterranean stem. Most of the specimens collected were of this type, developed from stolons, and only a very few were seedlings with the primary root present.

CARYOPHYLLACEAE.

Lychnis [Tourn.] L. sectio **Wahlbergella** Fries.

As a genus *Wahlbergella* was established by Elias Fries[3] and distinguished by the ovary being unicellular, the valves of the capsule bifid, and the seeds winged; the genus was placed between *Viscaria* and *Melandrium*.

[1] Bidrag till Groddknopparnas Morfologi och Biologi. Lund, 1857. p. 23. Tab. VII, fig. 16
[2] Dikotyla jordstammar. Acta Univ. Lund. xix: Lund, 1882-83.
[3] Botaniska Notiser. Lund 1843, p. 143

This same classification we find in Fries' Summa vegetabilium Scand. Stockholm (1846), with two species: *W. apetala* (L.) and *W. affinis* (J. Vahl), a diagnosis of the genus is given in this work (pp. 150-155): "Capsula uniloculares, dentibus 10 per paria connatis dehiscens, carpophoro stipitato. Semina angulosa, limbo (in nostris saltim) tumido corrugato marginata. Reliqua *Lychnidis* (*Melandryi*) diversae capsulae dentibus simplicibus et aequaliter distantibus. Quoad capsulam differt ut *Malachium* a *Stellaria*; quoad semina ut *Lepigonum* ab *Alsine*. Omnes species arcticae, micranthae, caulibus simplicibus."

That Fries also considered *Melandrium triflorum* (R. Br.) Vahl to belong to the genus may be seen from p. 155 (l.c.) where he writes: "Proxima est *W. triflorae* Vahl seminum margine vix limbato diversae." While the majority of Scandinavian authors, Blytt, Hartman, Kjellman, Lindman, etc. have accepted *Wahlbergella* as a genus, Lange [1] placed the species under *Melandrium* and recently Warming [2] follows the disposition of Lange.

Still another classification is proposed by Robinson [3] placing *Wahlbergella* as a member of *Lychnis* Tourn. sectio *Eulychnis* Fenzl (extended), and this author is certainly correct when stating: "Examination of a number of specimens seems to show that in American species the characters of partial septation of the capsule, division of the valves, inflation of the calyx, are very variable, and do not lead either individually or in combination to more definite or satisfactory results." As long as the genus *Wahlbergella* was known only to consist of the two species mentioned above, *W. apetala* and *affinis*, it was quite natural, but when increased with *Lychnis triflora* R. Br. and furthermore with *L. Taylorae* Robins., *L. montana* Wats., *L. Kingii* Wats., and *L. nesophila* nob., the generic distinction vanishes. On the other hand, these species may naturally represent a section of their own: the arctic alpine *Wahlbergella*; it is interesting to notice that a member of the section, *L. apetala* L. var. *gracilis* has been recorded from the alpine region of western Tibet, alt. 15-17,000 feet.

Th. M. Fries has described a variety *arctica* from Spitzbergen [4] the diagnosis of which reads as follows: "pedunculis dense cinerascente, subviolaceo-glanduloso-villosis; calyce subgloboso-inflato, magis patente glanduloso, vulgo apice sanguineo-violaceo, venis subnigricantibus longitudinaliter striato; petalis sub anthesi exsertis, violaceis (l. pallidis)." This variety was found on the coast of Wollaston land, as stated above. By the petals being very distinctly exserted this variety somewhat resembles *L. nesophila* nob. [5] from Mansfield island, Hudson bay, but differs with respect to the calyx being more inflated and also by the shape of the petals. Having studied various species of the section *Wahlbergella* in Greenland and Nova Zembla, and having examined numerous specimens from arctic Siberia and North America, I feel confident that *L. nesophila* is a distinct species. The diagnosis reads:

"Of the section: *Wahlbergella*; perennial, dwarfy, densely caespitose with a strong main root and woody branches; leaves crowded at the base of the flowering stems, linear-lanceolate, glabrous except the margins, which are hairy from slender, glandular hairs; stems prostrate, ascending, glandular hairy; flowers solitary, nodding; calyx cylindric, glandular hairy especially along the dark coloured nerves, five-toothed, the teeth ovate, obtuse; petals emarginate, serrate along the margins, protruding through the calyx, with distinct appendages, colour in dried specimens purplish; stamens ten, the anthers well developed; ovary rudimentary with frequently three to four styles."

With regard to the floral structure of *Wahlbergella* Lindman [6] has described the flower of *W. apetala* (L.) Fr. in his interesting and highly instructive: Contri-

[1] Conspectus Florae Groenl.
[2] Caryophyllaceae. Medd. om Grønland XXXVII. København, 1920
[3] Synopt. Flora of North America. New York, Cambridge, 1895 97, p. 224.
[4] Tillägg till Spetsbergens Fanerogamflora. (Öfvers. K. Vet. Akad. Förhdlgr. Stockholm, 1869 No. 22.)
[5] Fedde's Repert. III. 1907, p. 338.
[6] Bihang. K. Svenska Vet. Akad. Hdlgr., Vol. 12. Stockholm

butions to the knowledge of the flowering and fecundation of Scandinavian mountain plants. This author observed on Dovre mountain two types of flowers of this species, the one being larger but less conspicuous and with the stamens shorter; the other with the petals more developed and with longer stamens.

Lychnis apetala L. has a very long (about 40 cm.), persisting primary root which remains very slender, however; similar very long lateral roots proceed from near the crown of the primary one. While in small specimens the crown of the root bears a more or less compact rosette of leaves, such leafy rosettes are in larger specimens borne on a distinct complex of subterranean stem-bases at a distance from the crown, thus representing a pseudo-rhizome; in large specimens the diameter of the rosette measured about 12 cm.

L. affinis J. Vahl shows the same structure of the vegetative organs as the preceding but the plant is smaller. A very tall species is *L. Taylorae* Robinson, measuring in height about 28 cm. but of the same habit as the species described above; it was collected along Mackenzie bay by Rev. Isaac O. Stringer (1893).

Stellaria longipes Goldie var. **Edwardsii** Wats.

FIGURE E.

1. *Oxyria digyna* L.) Hill, showing the stolons and a rosette of leaves with a flower-bearing stem; natural size; specimen from Bernard harbour. 2. *Lychnis apetala* L. var. *arctica* Th. Fr.; flower-bearing stem; natural size; specimen from Wollaston land. 3. A petal of same; enlarged. 4. *Lychnis nesophila* nob.; flower-bearing stem; natural size; specimen from Mansfield island, Hudson bay. 5. A petal of same, enlarged. 6. *Stellaria longipes* Goldie var. *Edwardsii* Wats., showing a stem with leaves from the previous year, and young, floral shoots developed from the axils of the old leaves; 1⅔ times natural size; specimen from Port Epworth. 7. Same species; part of a stolon terminated by a flower; 1⅓ natural size; specimen from Bernard harbour. 8. Same species; a stolon; 1⅓ times natural size; specimen from Bernard harbour.

According to Warming (l.c. p. 255) "the primary root lives for a long time," but in none of the very numerous specimens of the typical plant and the varieties which I have examined was the primary root preserved. Characteristic of this plant is the profuse development of long stolons with small scale-like leaves and stretched internodes (Fig. E).

These aerial shoots are ascending and the leaves are more or less crowded on account of the shortness of the internodes. As pointed out by Kjellman [1] the leaves are still attached to the shoots when the winter commences but they are in a withered condition; the stems, on the other hand, remain alive and persist throughout the winter.

At the beginning of the spring small buds become visible in the axils of the faded leaves which soon develop into small leafy shoots (Fig. E: 6-8). These shoots frequently remain vegetative for one or two years until they become terminated by an inflorescence or a single flower. In specimens from Port Epworth the flower appeared already in the first season, as figured (Fig. E: 6). We have thus in this species of *Stellaria* a very interesting example of herbaceous aerial stems which winter over and produce axillary buds the function of which is to develop assimilating leaves, new axillary buds, and finally to produce flowers and fruit. This method of reproduction I observed also in the alpine plant in Colorado,[2] but in this the axillary shoots frequently reach the flowering stage already in the first year of their growth.

Several other species of *Stellaria* exhibit this type of vegetative reproduction, for instance: *S. longifolia* Muehl., *S. humifusa* Rottb., and *S. Holostea* L.

In *S. crassifolia* Ehrh. the withered stem-leaves subtend large buds, hibernacula, which winter over; they have been described by Norman[3], viz: "forma gemmificans. Caules saepe steriles vel pauciflori. Rami gemma terminali, compacta, saepius sordide violacea, ovato-globosa v. ovalia v. elliptica, usque ad 5 m.m. longa, e foliis katalyticis, carnosis, brevibus, ovalibus, obtusis, densis formata. Gemma sequente anno a ramo delapsa sensim elongatur, fibrillas radicales ramosas plures ex omni axilla protrudit, demum in caulem procumbentem, internodiis longioribus gaudentem, se producit."

Merckia physodes Fisch.

The primary root was not preserved in any of the specimens collected. For a comparison I have also examined material from Port Clarence, Alaska, from Moosehide mountain near Dawson, Yukon, and from Jakutsk, Siberia. Subterranean stolons are developed with minute scale-like leaves and with stretched internodes; capillary secondary roots develop freely from the nodi. The aerial shoots are long, prostrate, very leafy, and while many remain purely vegetative during the first season, some others develop a single, terminal flower; very often a long vegetative branch may develop from the axil of one of the leaves beneath the flower; thus it may look as if the flower were lateral but it is only apparently so. The prostrate aerial shoots develop no roots in the first year but in specimens which represented bases of old shoots roots were present, and these basal stem portions had gradually become buried in the soil. Characteristic of *Merckia* is thus the ability to wander not only by means of subterranean stolons but also by means of the long, prostrate, aerial shoots.

Cerastium alpinum L.

This forms large cushions borne upon a deep but slender primary root which branches freely. The numerous persisting stem-bases constitute a pseudo-

[1] Ur Polarväxternas lif, l.c.

[2] Method of hibernation and vegetative reproduction in North American species of Stellaria. (Am. Journ. of Science, Vol. XXV. New Haven, 1908.)

[3] Fiorae Arcticae Norvegiae species et formae (Christiania Vid. Selsk. Forhdl. Christiania, 1893, p. 20.)

rhizome and may remain active for several years. There is no leafy rosette as the cushion is formed only by the numerous branched shoots with their internodes very distinct, and with the leaves opposite.

Halianthus peploides (L.) Fr.

This is known best under this name; it is *Arenaria peploides* L., but the genus has also been called *Ammodenia* Patrin, *Honkenya* Ehrh., and *Adenarium* Raf. The vegetative reproduction is effected by means of long subterranean stolons with membranaceous leaves, scale-like and sheathing, which traverse the ground for some time until they seek the surface where they become transformed into aerial shoots with green typical leaves and flowers (Fig. F: 1); many of these stolons ramify freely in the ground; thus the individual represents a mass of floral and vegetative shoots. Very peculiar is the development of dwarfed shoots upon the subterranean nodi of the stolons. They have been described by Warming[1] and, as shown in the figures (Figs. 2-4), they are either simple or ramified. The axis is very short and the leaves of minute size and scale-like; they may persist for several years without developing any further, and, judging from the excellent material collected on the expedition, these shoots may die off without increasing any further in length. Or, as shown at the apex of the long stolon in fig. 2, they may become extended into aerial shoots. As mentioned above, these shoots may develop lateral shoots of the same structure; thus clusters of these may be seen at the root. With respect to the root-system, very thin secondary roots are developed here and there beneath the leaves of the stolons but they are not frequent and no roots were observed to proceed from the upper part of the stolons. No primary root was represented in any of the numerous specimens collected. The seedling stage has been described by Joh. Eriksson[2]; when growing in sand the cotyledons are hypogeic, and evidently by means of contractile roots the young plant becomes pulled down into the ground; besides true cotyledonary buds two pairs of accessory buds are developed above these.

FIGURE F. *Halianthus peploides* (L.) Fr.

1 Part of a large stolon bearing a lateral, more slender stolon which, on reaching the surface, bears green leaves and a flower; natural size. 2. Part of a large stolon bearing several dwarfed shoots, one of the apical having grown out and developed an aerial shoot; natural size; specimens from sandspit at Martin point, Alaska. 3 and 4. Two of the dwarfed shoots showing ramifications; in fig. 3 the basal leaves have dropped, leaving distinct scars; thus the shortness of the internodes are readily to be observed; enlarged

[1] Smaa biologiske og morfologiske Bidrag. (Botan. Tidsskr. 3 R. 2. Bd. Kjoebenhavn. 1877-79. p. 96.
[2] Studier öfver Sandfloran i östra Skåne. (Bih. K. Svenska Vet. Akad. Hdlgr. Vol. 22. Stockholm, 1896.)

Alsine verna Bartl. var. **rubella** (Wahlenb.) Lge.

Some very large specimens were collected; they form cushions of about 10 cm. in diameter, with an abundance of flowers. There is a persisting but thin primary root which is amply ramified. From the crown of the root numerous repeatedly branched shoots arise, but destitute of roots. Warming [1] states that in this species as well as in *A. biflora, arctica, hirta, groenlandica, macrocarpa,* etc. the ramification is monopodial; thus the primary shoot remains vegetative throughout the life of the plant.

RANUNCULACEAE.

Caltha palustris L.

Although absent from Greenland, Spitzbergen and Iceland, *Caltha palustris* nevertheless is circumpolar; farther south it is widely distributed in Europe, and on this continent it occurs in the Atlantic States east of the Mississippi, from the mountains of Carolina and Tennessee northward to Newfoundland, thence west to Minnesota and Saskatchewan; in some forms and varieties it occurs also in Alaska, along the northern coast of Canada, and in arctic Siberia. Naturally the species exhibits a somewhat different habit throughout a range of such enormous extent, and it seems more safe to conclude that the species is polymorphic, rather than to consider the modification in habit as being of specific importance. This may be readily appreciated when we compare the species as it occurs in the temperate regions of both Worlds with the types known from the more northerly latitudes.

In Norway, according to Blytt (l.c.), the stem is ascending from a decumbent, sometimes rooting base, and the foliage shows a reniform outline with the margin crenate; specimens with the stem rooting are by this author referred to the forma *radicans* Forst., known especially from Dovre mountain and Finmark. In Sweden the typical plant is common but Hartman records also the forma *radicans,* beside a form of diminutive size with the leaf-margin entire instead of crenate. In Russia, Ledebour describes the plant as having an erect or ascending stem with the leaves suborbicular or reniform, crenate along the margin; furthermore the form with the stem rooting is also recorded by this author. Ascherson [2] describes the German plant as having cordate leaves at the base but reniform above; Buchenau [3] makes the same statement but adds that all the leaves are crenate; this author made also the observation that the variety *laeta* Schott, in which the follicles are erect, was the most abundant while the var. *typica* Huth, with the follicles recurved, appears to be very rare. In France [4] *Caltha palustris* is quite frequent, and the leaves vary from reniform to somewhat cordate but always with the margin crenulate. According to Mathieu [5] the basal leaves of the Belgian plant are suborbicular, reniform, and crenulate at the base while the cauline are crenulate all round.

A similar leaf-shape is also characteristic of the American plant, and Torrey [6] describes this as "orbiculate-cordate or reniform, obtusely crenate, or nearly entire;" a variety *integerrima* (*C. integerrima* Pursh) is also mentioned in which the basal leaves are wholly entire but the cauline obscurely crenate. In Gray's Synoptical Flora a variety *radicans* Gray is described, the leaves varying from "dilated-reniform to nearly truncate at base;" and according to this author *C. radicans* Forst., *C. asarifolia* DC., *C. arctica* R. Br., and *C. palustris* var. *sibirica* Regel are merely synonyms of this variety. Finally may be mentioned that in some specimens from St. Croix Falls, Wisconsin, the margin is entire in the basal as well as in the cauline leaves, and the outline of the blade varies from reniform to completely round in the basal foliage while the stem-leaves are

[1] Caryophyllaceae (l.c.), p. 241.
[2] Flora der Provinz Brandenburg. Berlin, 1864. p. 17.
[3] Flora der nordwestdeutschen Tiefebene. Leipzig, 1894, p. 234.
[4] De Lamarck et De Candolle; Flore Française. T. 4, Part 2. Paris, 1815, p. 918.
[5] Flore générale de Belgique. T. 1. Bruxelles, 1853, p. 24.
[6] Flora of New York. Vol. I. Albany, 1843, p. 17.

merely reniform; on the other hand some very tall specimens collected near Peace river landing, Athabaska, by James M. Macoun, show the leaf-margin very finely crenulate and the outline roundish reniform with the sinus relatively narrow.

With regard to the arctic plant, typical *Caltha palustris* occurs in Nova Zembla from where it is reported by Kjellman and Lundstrom[1] and where I found it myself;[2] my specimens, however, are very small, measuring only from 5 to 7 cm. The forma *radicans*, on the other hand, is known from arctic Scandinavia, as stated above, and Kjellman found it also on the Asiatic coast of Bering strait, besides on St. Lawrence island. Furthermore, all the specimens collected on the Canadian arctic expedition represent this form (Fig. G: 1-2); and it is known also from the islands in Bering sea.

The Siberian plant, on the other hand, represents mostly the variety *sibirica* Regel, with the forma *radicans* Regel, characteristic of which is that the lobes of the leaf-blade form a very narrow sinus (Fig. 3).

FIGURE G

1. *Caltha palustris* L. forma *radicans* (Forst.) Hartm. A fruiting specimen from Herschel island showing three rooting shoots; two-thirds of the natural size. 2. A basal leaf of same form from the same locality; two-thirds of the natural size. 3. A leaf of *C. palustris* L. var. *sibirica* Regel forma *radicans* (Forst.) Reg. from Jakutsk, Siberia; two-thirds of the natural size.

In comparing the leaf-outline of these various specimens we notice that the leaf of the typical plant in Europe is mostly reniform with the margin crenulate, but varying to almost roundish, suborbicular; on the American continent the typical plant has the leaf-blade more or less reniform but, as stated above, the orbicular outline does also occur; the margin varies from crenulate to entire; the latter form is evidently *C. integerrima* Pursh. In Siberia the leaf-outline is generally roundish-reniform with the sinus narrow, a leaf-type that recurs in the Siberian f[illegible]na *radicans*. In other words, the form of which the stems are decumbent and rooting occurs throughout the northern hemisphere, and the

[1] Fanerogamer från Novaja Zemlja, etc. (l.c. p. 310.)
[2] Dijmphna Expedition (l.c.)

leaf-outline of this form agrees with that of the typical plant respectively from Europe and North America as well as from Siberia, the variety *sibirica* forma *radicans*. *Caltha palustris* may thus be considered a polymorphous species distributed over an area of quite considerable extent, and representing several analogous forms characterized by the structure of the foliar organs rather than by the floral.

Aconitum delphinifolium DC.

The tallest specimen measures a height of 25 cm. and bears several lateral racemes, shorter than the terminal one. With respect to the vegetative reproduction there is no rhizome, and the aerial shoot is borne upon a thick but short tap-root with many lateral roots of considerable length and relatively thick. When the winter commences a bud is developed in the axil of one of the lowermost leaves, and from the base of this bud a large tap-root will develop during the winter. This manner of reproduction resembles that of *A. uncinatum* L. which I have described in Merck's Report,[1] but differs from this by the bud remaining sessile and not being removed from the leaf-axil by means of the stolon-like stem so very plainly visible in *A. uncinatum*.

Anemone parviflora Michx.

Copious material was collected, and all the specimens represent the variety *grandiflora* Ulbrich.[2] It belongs to the section *Anemonanthea* DC. of which several species have been found on this continent, for instance: *A. trifolia* L., known also from Europe and Siberia, *A. quinquefolia* L., *A. oregana* Gr., *A. decapetala* Ard. et cet. In Europe the section is more frequent; it is represented by *A. nemorosa* L., *A. sylvestris* L., *A. baldensis* L., *A. palmata* L. et cet.

The section is according to De Candolle[3] defined as follows: "Car. Carpella ovoidea stylo uncinata hirsutissima villosa aut subglabra. Pedicelli in involucro solitarii aut rarissime bini umbellati, semper 1-flori nudi; sepala 5-15."

Flowering specimens are generally low, measuring only from 4 to 9 cm. in height, while fruiting specimens may reach the height of about 2 cm. The plant is perennial and has a horizontally creeping rhizome with slender stolons bearing tubular, membranaceous leaves; secondary roots are developed freely from the older part of the rhizome and beneath the aerial shoots. These shoots are erect with a subterranean ascending stem of the same structure as the rhizome, and when reaching the surface some green leaves become developed, which remain fresh during the first winter. The flower does not appear until the succeeding spring and by that time the leaves have withered. The shoots thus require two seasons to attain the flowering stage but they may persist for several years, producing alternately leaves and flowers.

As stated above, all the specimens from the Canadian arctic expedition represent the variety *grandiflora*, and in these the diameter of the flower (dried) measured about 3 cm.; this variety occurs also in Alaska and in northern Labrador. The typical plant from Churchill, Hudson bay, and from Jasper park, Alberta, is a taller plant but the flower is small, the diameter not exceeding 1·7 cm.

A. Richardsonii Hook.

This species belongs to the same section but it is of a much more slender habit than the preceding one. The rhizome is horizontally creeping and represents a monopodium until the first flowering stem develops. The internodes are stretched, slender, averaging in length from 3 to 7 cm.; one or two secondary

[1] March, 1907.
[2] A. Engler: Bot. Jahrb. Vol. 37, Leipzig, 1906, p. 172.
[3] Regni vegetabilis systema naturale, Vol. I, Pari 1818, p. 196.

roots, long, thin, and sparingly branched, develop close to the nodi, a little below these. With regard to the leaves of the rhizome, some scale-like leaves are developed but most of the leaves, however, are aerial, green, assimilating with the blade which is ample, deeply 5-cleft, and incised; the flower-bearing stem bears one pair of merely 3-lobed or 3-cleft, incised leaves which are sessile.

FIGURE 11

Basal leaf of *Anemone Richardsonii* Hook., from West Greenland; two-thirds of the natural size.

There seems to be no regularity with reference to the position of the scale-like leaves; they may occur on any part of the rhizome, preceding or succeeding the green leaves. And when the rhizome ramifies the secondary branch may develop from the axil of a scale-like leaf or from the axil of a green one.

While most often a green leaf is to be observed at the base of the flowering stem and subtending the bud which is to develop and continue the horizontally creeping rhizome, this green leaf may be replaced by a scale-like one. Otherwise the most frequent case is that the last leaf of the primary rhizome is aerial and green, and that it subtends the secondary branch which is to continue the growth of the rhizome in the same manner and in the same direction as if the entire rhizome were a monopodium. For instance, in a specimen from St. Paul island, Bering sea, which my late friend Mr. James M. Macoun collected for me, the rhizome measures seventy-two cm. in length, as apparently one single axis with no other sign of its sympodial structure but some few, minute scars from the withered flowering stems; on this very long rhizome only one green leaf and a flower-bearing stem were developed at the apex, and a young stolon proceeded from the axil of the green leaf.

In comparing the plant as it occurs in Greenland, on the Arctic coast of this continent, and on the coast of Alaska and adjacent islands, no particular structure of the rhizome, with reference to the foliage or flower-bearing stem, seems to be characteristic.

Some more or less interesting structures may be mentioned as follows: A specimen from Beaver inlet, Unalaska, showed the main rhizome destitute of green leaves, and at the base of the flower-bearing stem a scale-like leaf subtended the stolon; but from the posterior part of the rhizome, from the axil of a scale-like leaf, a similar stolon had developed, bearing a typical, green leaf; in another specimen from the same locality the main rhizome bore two green leaves and a floral shoot; these two leaves were separated from each other by an internode about 5 cm. in length; in this same specimen the young stolon at apex bore two scale-like leaves preceding a very young, not quite developed green leaf. In a specimen from Cook inlet, Yukon river, the rhizome measured about 20 cm. in length and bore three green leaves and a flower-bearing stem. A much shorter rhizome from Kodiak, Alaska, measuring only 7 cm., bore two green leaves and a floral stem; beside that the apical stolon bore a fully developed

green leaf, preceding a scale-like one and a very young green one. Finally, in some specimens which I collected in Greenland, near Holstensborg, the apical stolon had developed into a floral shoot; thus two flowering stems were developed contemporaneously.

A. Drummondii Wats.

Only some few specimens with the leaves withered were collected as late as November but the structure of these leaves agrees very well with that of this species, and much more so than with *A. multifida* Poir. *Anemone Drummondii* was also collected on the Gjöa expedition (l.c.), and the photographic reproduction of a flowering specimen leaves no doubt as to the correctness of the identification.

As far as habit is concerned, *A. Drummondii* is densely caespitose with a very deep, woody, primary root which branches freely towards apex. Several erect or ascending shoots arise from the crown of the root, measuring in height about 4 cm.; when reaching the surface these shoots develop rosettes of leaves and terminal flowering stems.

Ranunculus Pallasii Schl.

Of this stately plant several flowering specimens were collected in a pond on the tundra at Konganevik, Camden bay; they measured in length about 20 cm. We meet here with the same structure of shoot as in *Anemone Richardsonii* but scale-like leaves are absent. As long as the shoot is purely vegetative, the ramification is monopodial, but, when the flower appears, and this terminates the axis, the shoot becomes a sympodium. Branches of *R. Pallasii* thus show a few stretched fistulous internodes, about 10 cm. in length, and some leaves with long petioles, subtending shoots, while opposite the leaf a tall peduncle (about 10 cm.) arises bearing a single flower; in the specimens from Konganevik some of the lateral shoots had already developed a green leaf and a terminal flower-bud. With respect to the foliage, it may be stated that the earliest developed leaves have very small blades which are oblong or linear and borne upon long, fistulous petioles. In mature specimens the leaf-blades are larger, entire or 3-lobed, the middle-lobe being longer than the lateral ones; however, in specimens from Hudson bay (Lat. 60° 42′) the leaf-blade is 3-cleft, with the lateral lobes relatively long and narrow. The root-system consists of many very long, slender, secondary roots proceeding from the nodi.

A hybrid, *R. lapponicus* × *Pallasii*, has been described and figured by Andersson and Hesselman in a paper dealing with the flora of Spitzbergen and Beeren Eiland,[1] previously described by A. G. Nathorst as a variety "*spetsbergensis*" of *R. Pallasii*. In this hybrid the leaf-blade is always three-cleft, the lobes entire or with the margin dentate or even lobate; the flower is smaller than in *R. Pallasii* and of a yellowish-white colour. A large table is given showing a number of points by which the hybrid is distinguished from the parents, and several figures of leaves, petals, stamens and fruits accompany the text. Of special interest is the fact that this hybrid is the first which has been found in Spitzbergen.

R. Purshii Richards. and **R. hyperboreus** Rottb. were found in shallow ponds, both with the leaves floating. Of these, the former was collected with ripe fruits on Herschel island, while the specimens from Cape Bathurst were sterile, with no flowers at all, and with the leaf-blades of very diminutive size. All the specimens of *R. hyperboreus* were sterile with the leaf-blades very small.

[1] Bihang K. Sv. Vet.-Akad. Hdlgr. Vol. 26, Stockholm, 1900.

FIGURE 1.

1. *Ranunculus lapponicus* L., specimen from Tree river, showing the apical portion of the rhizome (R.), with two green leaves (L^1 L^2) and a stolon (St.) developed in the axil of L^2. One and two-thirds natural size. 2. Same species; apical portion of the rhizome (R.); S = the flowering stem; other letters as above; enlarged. 3. Same species; part of the rhizome with three green leaves (L^1-L^3); stolons are developed in the axils of L^1, L^2, and L^3; letters as above; natural size. (Figures 2 and 3 are drawn from Swedish specimens).

R. Cymbalaria Pursh var. **alpina** Hook.

Found with the flowers fully developed, and showing the same habit as farther south, with long stolons above ground. The species is well equipped for propagation and widening of its range of occurrence, even though the individuals are very small and the flowers always single.

R. pygmaeus Wahlenb.

Numerous specimens were collected with flowers and young fruit; in spite of the small size of the plant, the shoot above ground measuring seldom more than 2 cm. in height, the vertical rhizome extends to a depth of about 2.5 cm. and bears numerous slender, ramified roots.

R. lapponicus L.

Like *Anemone Richardsonii* and *R. Pallasii*, this species has a horizontally creeping rhizome, and the ramification is monopodial until the first flower appears. A young rhizome (Fig. 1: 1) from a specimen collected on the south coast of Coronation gulf thus shows part of the rhizome (R.) bearing two green leaves (L^1 and L^2), while the terminal part of same rhizome (St.) is terminated by a free bud; secondary roots, long and slender, are developed beneath the first leaf (L^1).

An older specimen (Fig. 2) from Norrbotten, Sweden, shows the structure of the mature plant. The posterior part of the main rhizome is by R; it bears a green leaf (L^1) and is terminated by a flower of which or basal portion of the peduncle has been shown (S.); in the axil of leaf L^1 is zontal shoot (St.) of which the first leaf is green (L^2) and of the same si shape as leaf L^1. The horizontal shoot (St.) bears at the apex a young leaf unfolds in the succeeding season. In this way the axillary, horizontal s stolon (St.) will continue its growth in the same direction as the main r (R.). In old specimens it thus appears as if the entire horizontally rhizome were an axis of the same order but, as shown above, it actu of several axes and represents a sympodium.

Several deviations from this structure occur, as is also the case *Richardsonii*. For instance, as shown in Fig. 3, a stolon may be from the axil of the second leaf (L^2) beside from the leaf (L^3) borne floral peduncle (S.). But otherwise the ramification is the same becau flowering stem (S.) terminates the rhizome (R.) while the stolon (St.) is dev from the axil of the first leaf (L^1), bearing a green leaf (L^2) which again su a stolon. This specimen thus shows three stolons, all being axillary. No like leaves were observed in any part of these rhizomes. *Ranunculus lapp* grows in moist ground, principally in bogs, and the internodes of the r may reach a length of 10 cm. or even more; the specimens from Cor gulf were rather low, the flowering stem reaching a height of only 8 cm. specimens from Sweden may average double the size, or more, when i

R. nivalis L. and **R. sulphureus** Soland. exhibit the same growth sometimes, it has proved difficult to distinguish them from each othe facilitate the identification a brief diagnosis of *R. sulphureus* given by

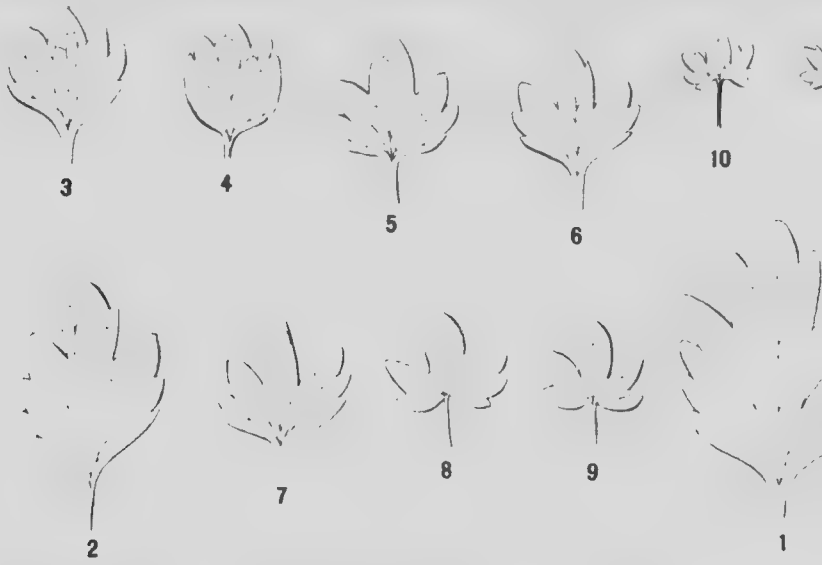

FIGURE K

Basal leaves of *Ranunculus sulphureus* Soland. (1-7), and *R. nivalis* L. (8-11), all tw of the natural size.

1 Specimen from St. Paul island, Bering sea. 2. Specimen from Eumatowan, Siber Specimen from Magdalene bay, Spitzbergen. 4. Specimen from Jakutsk, Siberia. men from Tromsö, Finmark. 6. Specimen from Camden bay, Alaska. 7. Specim Magdalene bay, Spitzbergen. 8. Specimen from St. Matthew island, Bering sea. men from Dovre mountain, Norway. 10. Specimen from Cape York, West Greenla Specimen from Godhavn, Disco, Greenland.

(Conspectus. l.c. p. 56) may be inserted here. It reads as follows: "*R. altaicus* Laxm. (*R. sulphureus* Soland.) praecedenti (*R. nivalis* L.) arcte affinis, a quo recedit praecipue habitu robustiore, foliis radicalibus basi rotundatis v. cuneato-contractis (nec reniformi cordatis), breviter (nec ultra medium) lobatis, caulinis fere ad basin usque 5-7- fidis, petalis pallidioribus, sulfureis, stylo breviore. In speciminibus Groenlandicis lobos fol. radic. integros, nec ut DC. (Syst. veg. 1. p. 274) indicat, dentatos invenis."

For comparison I insert some figures of the basal leaves of both species (Fig. K). They both are perennial, but the subterranean stem is relatively short, vertical or ascending, densely covered with old, withered leaf-sheaths; secondary roots develop from the nodes of the stem, and the primary root is of short duration, being totally absent when the plant has reached the flowering state.

R. affinis R. Br. (Chloris Melvill. l.c. p. 189).

This is sometimes difficult to distinguish. The original diagnosis reads as follows: "foliis radicalibus pedato-multifidis petiolatis; caulinis subsessilibus digitatis; lobis omnium linearibus, caule erecto 1-2-floro cum calycibus ovariisque pubescentibus, fructibus oblongo-cylindraceis, acheniis rostro recurvo. Obs. *R. auricomo* proxima species."

Lange[1] gives the following supplementary diagnosis: "Folia radicalia reniformia, leviter lobata v. magis minusve profunde palmatifida; petala pallide lutea, subtus fusco-venosa, minora et angustiora quam *R. auricomi;* capitulum carpellarum ovali-oblongum (nec subglobosum), ceterum *R. auricomum* L. affinis, sed humilior et gracilior."

According to Lange (l.c.) *R. affinis* is very rare in Greenland; it is known from East Greenland: Fr. Joseph's fjord 73°, and from West Greenland: Arsalik in Isortok fjord. From the latter station some specimens have been figured in Flora Danica Vol. 17. Tab. 3029 (1883), and these specimens give a good representation of the species as well as the photographic reproduction of specimens from Harbour fjord in Simmons' Flora of Ellesmere Land.[2] On the accompanying plate I have figured a flowering specimen from Bernard harbour and an achene taken from a fruiting specimen from Epworth harbour; the leaf (Fig. 2) is from Bernard harbour.

While the typical species occurs in Spitzbergen, according to Nathorst,[3] this author found also a plant which proved so different from typical *R. affinis* that he described it as a subspecies: *Wilanderi*. Nathorst calls attention to the following distinctive characters possessed by this subspecies: it is of low stature and caespitose; the fruiting head is roundish, not cylindrical; the carpels are thinner, with the body only a little longer than the recurved, rather coarse beak. A figure is given by Anderson and Hesselman in their interesting account of the Flora of Spitzbergen and Beeren Eiland (l.c.). J. Freyn, however, ("in litteris," compare Andersson and Hesselman l.c.) on examining this plant as well as the material of typical *R. affinis* collected by these authors, has reached the conclusion that the specimens must be referred to *R. arcticus* Richards. and that *R. affinis* does not grow in Spitzbergen at all; furthermore, this author insists that all the material from Siberia, Davuria and Spitzbergen named *R. affinis* is actually *R. arcticus*, and that *R. affinis* is confined to western North America, viz.: the Rocky mountains, extending from there to Melville island. This statement seems rather peculiar when we remember that Richardson's *R. arcticus* came from arctic North America, collected on the first Franklin ex-

[1] Conspectus Fl. Groenl. (l.c.) p. 57.

[2] Report on the Second Norwegian Arctic Expedition in the "Fram," 1898–1902. No. 2. Christiania. 1906.

[3] Nya Bidrag till Kännendomen om Spetsbergens Kärlväxter (Kgl. Sv. Vet. Akad. Hdlgr. 20. No. 6. Stockholm, 1883, p. 23.

pedition. A very detailed account of *R. affinis*, including *R. arcticus*, is given by Simmons (l.c., p. 101). However, as long as the identity of *R. arcticus* is disputed it may be well to reprint the diagnosis, inasmuch as the work in which it is published may not be readily accessible to many of the readers.[1] Richardson described the species as follows: "*R. arcticus*: foliis radicalibus petiolatis hastatis tripartitis lobis divisis; caulinis in lobos lineares integerrimos partitis, caulo trifolio unifloro, calyce villoso petalis breviore (B.)[2] Folia glaberrima; radicalia longius petiolata, hastata, tripartita; lobo intermedio unguiculari trifido, laciniis lateralibus minoribus, patentibus lobis lateralibus 4-partitis segmentis divaricatis, exterioribus sensim minoribus; laciniis omnibus obtusis, lanceolatis vel linearibus; caulina in lobos lineares integerrimos, obtusiusculos partita, ad bases membranacea, amplexicaulia et pilis albis mollibus ciliata; imum subpetiolatum lobis sex, summum lobis tribus. Caulis simplicissimus pedalis erectus uniflorus, foliis tribus remotis munitus et supra folium summum pilis albis villosiusculus. Calyx flavescenti-erubescens, villosus, reflexus, petalis dimidio brevior. Petala lutea patentissima, obovata, obtusissima, receptaculo breviora. Stamina filamentis brevissimis, antheris oblongis. Germina glabra stylo recurvato mucronata, receptaculo cylindraceo."

Ranunculus arcticus Richards. was thus established on a plant which was collected on the barren grounds from lat. 64° to the Arctic sea, in lat. 69°, and it was published in the same year as Robert Brown's Chloris Melvilliana (1823); however, in the second edition of Franklin's Narrative Richardson adopts the name *R. affinis* of Robert Brown. By Gray (Synopt. Flora l.c., p. 31) *R. arcticus* is given as a synonym of *R. affinis*; another synonym is *R. amoenus* Karel. et Kiril. according to Ledebour (Flora Rossica, l.c., p. 732). In recent years some American authors have adopted the name *R. pedatifidus* Sm. instead of *R. affinis* R. Br. but Simmons (Flora Ellesmereland l.c., p. 102) has clearly demonstrated that Smith's and Robert Brown's plant are not conspecific. Simmons having seen the original specimens of the former, *R. pedatifidus*, states that the basal leaves are almost circular in outline and deeply cut into numerous, almost linear segments, with a smaller median, and two larger lateral lobes, a structure which does not occur in *R. affinis;* according to this author *R. pedatifidus* Sm. is a native of Asia, especially Eastern Siberia, besides some of the islands in Bering sea.

Several very fine specimens were collected by the Canadian Arctic expedition, measuring in height from 6 to 12 cm. in flowering specimens; withered stems with the fruit from the year previous were about twice as tall. Part A Plate II, Figs. 1-3 illustrates one of these specimens, and the American plant agrees exactly with that from Siberia, Nova Zembla, Spitzbergen and Greenland.

The species is perennial; the primary root soon becomes replaced by a number of slender, secondary roots developed from the nodi of the short, erect rhizome. Several basal leaves surround the flowering stem which bears several long-peduncled flowers in a unilateral cyme.

Ranunculus Sabinii R. Br.

This is described by Robert Brown:[3] "foliis radicalibus elongato petiolatis tripartitis: lobis ellipticis: lateralibus semibifidis; caulinis sessilibus tripartitis linearibus, calycibus hirsutis petala retusa subaequantibus. Obs. planta inter *R. nivalem* et *pygmaeum* media in Herb. D. Sabine exstat, ulterius examinanda forsan haud distincta a *R. nivali* cujus cfr. icon. Flor. Dan. 1699, ubi petala retusa et folium radicale pinnatifidum."

[1] John Franklin: Narrative of a journey to the shores of the Polar Sea in the years 1819-20-21 and 22. London, 1823.

[2] B. denotes the Barren Grounds from Point lake to the Arctic sea.

[3] Chloris Melvilliana (l.c., p. 189).

In Gray's Synopt. Flora (1895-97, p. 29), the species is mentioned only as a synonym of *R. pygmaeus* Wahlenb.

The affinity of the species is undoubtedly with *R. pygmaeus* Wahlenb. and several specimens which I have examined may well be mistaken for large specimens of the latter, notably some collected by Simmons in Ellesmereland (Muskox fjord); more typical are the specimens from Cape Bathurst which are of considerably larger size with respect to foliage and flowers, and in some of these the fruiting stalk from the year previous is still preserved; it is strict and measures the height of 14 cm. The specimens from Ellesmereland, on the other hand, show the fruiting stalk arched and bent toward the ground as in *R. pygmaeus*. *R. Sabinii* is perennial, of exactly the same habit as *R. nivalis* and *affinis* as far as concerns the rhizome, the roots, and the inflorescence.

PAPAVERACEAE.

Papaver nudicaule L.

According to Fr. Fedde [1] the plant from the arctic and northern part of the subarctic countries represents the subspecies *P. radicatum* (Rottb.) Fedde; specimens were collected at many stations visited by the expedition.

The species is perennial with the primary roots persisting for several years as a deep and relatively thick tap-root which bears many slender, lateral ramifications. Several erect or ascending shoots proceed from the crown of the root, and, on reaching the surface, they develop green leaves and flower-bearing stems, each with a single flower. Large specimens are thus of a caespitose growth in which the leaves form crowded rosettes like cushions, reaching the width of about 12 cm.; in such specimens the numerous shoots may reach the length of about 5 cm. beneath the surface; they are densely clothed with the persisting leaf-sheaths from previous years. In the tallest specimens the flowering stem measured about 14 cm., the fruiting one up to about 22 cm., but most of the other specimens were much lower.

CRUCIFERAE.

Lesquerella arctica (Rich.) Wats.

This is a perennial herb with a deep, slender, freely branching, persisting primary root crowned with a compact rosette of leaves from the axils of which the ascending flower-bearing stems arise; the ramification of the shoot is thus monopodial. The rosette of the largest specimen measured 6 cm. in diameter; the height of the flowering stems was about 10 cm.

Cochlearia groenlandica L.

Collected as late as the tenth of August, at Bernard harbour, several minute specimens were commencing to bloom; in these the diameter of the rosette measured only 1½ cm., the height of the flowering stem 1 cm., and the very thin, primary root about 4 cm. in length. Such small specimens were growing with large ones, about 5 cm. high, and with almost mature pods.

Draba alpina L.

A large number of specimens were collected of this species, the largest forming a compact cushion measuring in diameter 10 cm., with the flowering stems only 3 cm. in height. The primary root persists throughout the life of the plant and attains a considerable length, but is generally slender; only in one specimen did it measure about 3 cm. in thickness. In some very old specimens

[1] A. Engler: Das Pflanzenreich. Leipzig, 1909, p. 376.

from Bernard harbour did the height of the cushion measure 5 cm.; in such specimens the structure of the shoot could be followed from the earliest stage of the plant. From the crown of the primary root numerous shoots proceeded, densely covered with appressed, withered leaves and reaching a height of about 4 cm., whence a system of terminal and lateral rosettes commenced. In other words, the complete vegetative system of branches and leaves is above ground and winters over as such.

Among the plants which Kjellman studied at the most northerly point of Asia, Cape Tscheljuskin, *Draba alpina* represented the remarkable habit of forming compact balls of which the greater portion of the shoots, and especially the youngest ones, were completely above ground. A corresponding habit was also observed in *Eritrichium villosum*, *Saxifraga serpyllifolia*, *Papaver nudicaule*, *Stellaria longipes* et cet.[1]

D. nivalis Liljebl. and **D. fladnizensis** Wulf.

These species from Camden bay and Bernard harbour illustrate exactly the same habit as observed in *D. alpina*.

D. hirta L.

D. hirta L., on the other hand, does not seem to persist for so many years as the three foregoing species. It is a tall plant as compared with most of the other *Drabae*, reaching the height of about 20 cm. when in bloom, such specimens having been collected on the south coast of Coronation gulf. The primary root is relatively short and thin and only a few rosettes of leaves are developed, each of which is terminated by an inflorescence.

Braya purpurascens (R. Br.) Bunge.

Has a monopodial shoot, the youngest specimens showing very plainly a central, leafy axis and two lateral inflorescences; in old specimens the ramification is obscured by the several leafy shoots being crowded, and the lateral position of the floral stems is only indicated by these being ascending, not strictly erect.

B. glabella Richards.

Only a single specimen was collected of this very rare species, known only from the arctic coast of this continent, from East Greenland, and from a few stations in arctic Scandinavia. It is readily distinguished from *B. purpurascens* by the leaves being remotely dentate, and by the long, linear pods. The specimen from Wollaston land measured a height of about 12 cm., and although being a young specimen eleven flowering stems were developed from the small rosette of leaves; the primary root is relatively short, slender, and much branched.

Eutrema Edwardsii R. Br.

In young specimens the primary root is slender; there is no rosette and only two to three long-petioled leaves at the base of the single, terminal, flower bearing stem. In the older specimens the primary root is quite thick, distinctly wrinkled, and as many as six flower-bearing stems are developed from the crown of the root, besides several green leaves. The height of the flowering stem aggregated about 15 cm., that of the fruiting stem very nearly 20 cm.

Hesperis Pallasii (Pursh) T. et Gr. [*H. pygmaea* (Adams) Hook.]

In Gray's Synoptical Flora it is described as a dwarf biennial plant, but according to the numerous and exceedingly well preserved specimens collected by the expedition, it is a perennial and not always of dwarfed stature either

[1] Ur Polarväxternas lif (l.c., p. 475).

a flowering specimen from the south coast of Coronation gulf measures in height no less than 18 cm., and a fruiting specimen from Herschel island 10 cm., the mature pods averaging about 8.5 cm. in length. The specimens from Bernard harbour, on the other hand, are very low, representing compact cushions of leaves from 2 to 6 cm. in diameter; in such specimens the flowers are barely raised above the leaves.

As stated above, the plant is perennial which is readily to be seen from the subterranean stem-portion bearing numerous remnants of leaves from previous years and emitting short lateral branches with rosettes and flowers; moreover, in several old specimens small leafy rosettes were developed, but still too young to produce flowers. The large fruiting specimens from Herschel island have many green leaves in clusters, indicating that future growth is secured. The primary root persists throughout the life of the plant and increases quite considerably in thickness and length, ramifying freely, the lateral branches equalling the primary in length.

Cardamine pratensis L.

This seems to thrive well on the arctic shore; the specimens are tall and blooming freely; a specimen from Port Epworth harbour measures 24 cm. in height and bears three lateral racemes developed from the axils of the cauline leaves. It is a point of interest to notice that in some of these high northern specimens (Coronation gulf) vegetative reproduction is secured by means of adventitious buds developed upon the basal leaves close to the leaf-segments. These buds upon the leaves of *Cardamine* were described already by Cassini; while still in connection with the leaf they develop some small leaves and roots and, when liberated, they continue their growth and develop new independent individuals. Similar buds are known also from a few other plants. Turpin observed them in *Ornithogalum*, Henslow in *Malaxis*, and according to Lindley [1] they abound in *Bryophyllum* and *Tellima grandiflora*.

With regard to the fruit in *Cardamine*, the specimens showed mostly flowers and only a few young pods were developed. Thus in case of failure to produce seeds, *Cardamine* would be able to become distributed by means of the adventitious buds.

C. digitata Richards.

In a monograph of the genus *Cardamine* O. E. Schultz [2] rejects Richardso name "*digitata*" because the genus has become merged into the genus *Dentaria* of which there is a species "*digitata*" of older date, thus necessitating the creation of a new name for Richardson's plant.

"*Dentaria digitata* Lamarck" must consequently be renamed *Cardamine digitata* (Lam.) Schultz, and "*C. digitata* Richards." must bear the name *Cardamine hyperborea* Schultz. However, it all depends on the concept of the two genera *Cardamine* and *Dentaria*, whether they should be kept separate or be united. This question has been raised before by some of the ablest botanists abroad and on this continent and the question seems to be well solved by Gray, Greene, Nuttall, Sereno Watson, and several others who were familiar with the species of both genera as represented on this continent, maintaining the genus *Dentaria* as distinct from *Cardamine*.

With respect to the subterranean stem, *C. digitata* possesses a slender, horizontally creeping rhizome which bears aerial, green leaves and which is also stoloniferous. In this way the species is better equipped to become distributed than *C. pratensis* in case of failure to produce mature seeds in unfavourable seasons. By the constantly smaller size of the flowers, the shape of the leaves, and especially by the rhizome, *C. digitata* is a good species, and well distinguished from *C. pratensis*.

[1] Introduction to Botany. London, 1832, p. 50.
[2] Engler's bot. Jahrb. Vol. 32. Leipzig, 1903, p. 550.

Parrya macrocarpa R. Br. [*Matthiola nudicaulis* (L.) Trautv., *Parrya nudi caulis* (L.) Regel.]

Several flowering and fruiting specimens were collected; during the flowerin the height of the stem averages about 10 cm. The primary root is deep, an very thick, bearing at the crown some few short erect or ascending shoots densely covered with remnants of old leaves, and terminated by a fascicle o leaves surrounding the flowering stem. With regard to the vegetative repro duction, it would appear as if the species is very poorly equipped, since ther is no other subterranean stem than the very short pseudo-rhizome, describe above. However, the root-system shows that the plant is by no means unabl to wander and thus become distributed in a vegetative manner since the larg tap-root frequently branches and some of these branches, especially the hor zontal ones, are able to produce new plants as root-shoots.

For instance, some flowering specimens collected on Herschel island an Wollaston land were actually root-shoots, with the mother-root still attache Similar root-shoots occur in a number of plants; Wittrock [1] has written a interesting paper on this subject furnishing a comprehensive list of species tha multiply in this manner. Among the Cruciferae Wittrock mentions some speci of *Arabis, Cardamine resedifolia, Lepidium latifolium, Alliaria,* and severa *Nasturtia.*

P. arctica R. Br.

A relatively smaller plant than *P. macrocarpa* but the root is also here quit thick and deep. The aerial shoot, inflorescence, and leaves, agree with that o the preceding, but I found no specimens developed from roots.

Erysimum inconspicuum (Wats.) MacMill. [*E. parviflorum* Nutt., no Pers.]

The tall flowering stem (about 24 cm.) arises from a small rosette of leave borne upon a slender but persisting primary root which ramifies freely; th species is perennial.

Sisymbrium sophioides Fisch.

On Herschel island this species may persist for more than one season, a shown by a very large specimen with six flower-bearing stems reaching th height of about 30 cm. and arising from a large rosette of leaves; the thic primary root bears evidence of having been active for at least two seasons The specimen was collected in the month of August and with it several muc smaller specimens were collected. Averaging only 3 to 5 cm. in height, thes plants were in bloom, and the rosette of leaves was perfectly fresh; thus the might be able to winter over. It deserves attention that this species is generall described as an annual and that it occurs as such in arctic Scandinavia (70° N.L according to Blytt;[2] it has also been found near Ivigtut, on the west coast o Greenland, but as an introduced weed only.

CRASSULACEAE.

Sedum Rhodiola DC.

The very carefully lifted specimens form relatively large compact cushion with the numerous low, flower-bearing stems, about 5 cm. in height, borne upo fleshy subterranean branches with numerous withered stems from previou years, and terminating in a deep, relatively slender, primary root. As com pared with Greenland specimens, those from Martin point, Alaska, are muc less robust with respect to the size of leaves and inflorescence.

[1] Botan. Notis. Lund, 1884.
[2] Norges Flora, p. 995. Christiania, 1861.

SAXIFRAGACEAE.

Chrysosplenium alternifolium L. var. **tetrandrum** Lund. [*C. tetrandrum* Th. Fries.]

This is a very small perennial herb. With respect to the morphological structure, the variety agrees with the typical plant, as described by Irmisch.[1] The almost filiform primary axis consists of long internodes and bears small, scale-like leaves with a minute, rudimentary blade. At the apical part of the stem the leaves are green, long-petioled, and bearing a roundish, reniform blade. Secondary roots develop freely from the internodes. Flowering as well as purely vegetative shoots may develop from the axils of the lowermost green leaves; more frequently, however, stolons are developed from the axils of these leaves. The stolons have long internodes, and the leaves are scale-like or, towards apex, green and of the typical shape; axillary stolons develop sometimes from the leaf-axils of the mother-stolon; thus the plant shows quite a compact mass of shoots, of which the stolons gradually become separated from the mother-axis and develop new, independent individuals.

Parnassia Kotzebuei Cham. et Schl.

The species is caespitose with a very short, erect, subterranean stem from which numerous long, slender, secondary roots are developed. There are no scale-like leaves, and the foliage forms a small rosette from the centre of which the flower-bearing stems arise. Judging from the structure of some young specimens, it appears as if the first flower-bearing stem terminate the primary shoot, and the vegetative reproduction is secured by means of one or several buds developed in the axils of the rosette leaves. These buds may be purely vegetative for a season or so and they may be separated from the mother plant and give rise to new individuals. Beside these vegetative buds there are also some others which are floral and develop during the succeeding year. No distinction was to be observed with regard to the external structure of these buds; they were not protected by scale-like leaves and their position in the rosette was not the same; thus flowers and vegetative shoots may be seen in the same specimen to have developed in no particular order. The species thus agrees with *P. palustris* L., according to the description given by Hj. Nilsson (Dikotyla jordst. l.c., p. 168).

Saxifraga [Tourn.] L.

The fifteen species collected by the expedition represent the following sections according to Engler:[2] *Nephrophyllum* Gaud., *Hirculus* Tausch., *Boraphila* Engl., *Dactyloides* Tausch., *Trachyphyllum* Gaud., and *Porphyrion* Tausch. The number of species enumerated and described by Engler (l.c.) aggregates 166, and many of these exhibit a geographical distribution of enormous extent, throughout the northern hemisphere, and to the highest elevations in the mountains.

Owing to this very wide distribution the genus naturally exhibits quite a number of morphological structures which may well be looked upon as epharmonic characters. Nearly all the species are herbs, and they are generally small plants, but with the flowers quite conspicuous and of delicate structure; very characteristic of the genus is the immense variation in leaf-outline; we have a number of species that exhibit the same leaf-shape as various genera of other families. For instance, there is a species called "*aconitifolia*," and among others may be mentioned "*ajugaefolia*," "*cortusaefolia*" "*hederacea*," "*hieraciifolia*," "*heucherifolia*," "*juniperifolia*," "*leucanthemifolia*," "*parnassifolia*," "*ranunculifolia*," etc.—As stated above, the habit is extremely different, and regardless of the

[1] Zur Morphologie der monocotylischen Knollen und Zwiebelgewächse. Berlin, 1850, p. 192.
[2] Monographie der Gattung Saxifraga. Breslau, 1872.

nature of environment several very distinct types of habit may be observed a the same station, whether in the far north or in the alpine regions of the moun tains. Thus among the plants which are growing nearest the Pole, betwee 82° and 83° 24′ N., gathered by the British polar expedition, 1875-76, and th late Lieut. Lockwood, United States Army, we find not less than six species o *Saxifraga*, viz.: *S. cernua*, *S. nivalis*, *S. decipiens*, *S. tricuspidata*, *S. flagellaris* and *S. oppositifolia*. And according to Hooker[1] *S. cernua* and *S. flagellari* ascend to an elevation of above 17,000 feet in the Himalayas; furthermore, i the Rocky mountains, Colorado, I collected *S. cernua*, *S. flagellaris*, and *S nivalis* above 14,000 feet alt. In other words, the sections which are able t thrive at the stations farthest north are *Nephrophyllum*, *Boraphila*, *Dacty loides*, *Trachyphyllum*, and *Porphyrion*; three of these: *Nephrophyllum Boraphila*, and *Trachyphyllum*, are among those that ascend to the highes latitudes.

As pointed out by Engler (l.c. p. 57), the majority of the species are moun tain plants and many of these belong to the alpine flora. This author gives an interesting table according to which the largest number of species occur in th European Alps from France to Croatia (42 sp.); then follow Tibet and the Himalayas with 35 species, the Pyrenees with 30, the Carpathian mountains with 25, the Rocky mountains with 22, etc. Only 5 species are credited to the South American Cordilleras.

The majority of the species are herbaceous [illegible]y few are annual, and several may be designated as undershrubs. Among the perennial herbaceous ones some interesting structures are to be observed with respect to the vegetative reproduction, the development of runners above the ground, and of bulblets developed in the axils of the leaves, the basal as well as the cauline, in the latter case representing transformed flowers as in *S. cernua* and *S. stellaris* forma *comosa*, for instance. But although the primary root persists in many species no instance is known, so far, where the root increases in thickness to any great extent, as is otherwise a feature characteristic of various mountain plants, especially the alpine ones.

The arctic species collected by the expedition constitute actually an assemblage of types in which the vegetative reproduction gives an excellent illustration of the biology of the genus in the arctic and alpine regions.

Saxifraga aestivalis Fisch. et Mey.

The plant upon which Linnaeus established the species came from Siberia, and according to Ledebour the species occurs also in Alaska and aretic America. However, some Siberian specimens which I have before me, collected near Jakutsk (N. H. Nilsson), and at Tolstoi Nos (M. Brenner) differ from the Alaskan as well as from the arctic American by the leaves (Fig. L: 3) being of a more round ish outline and of a thinner texture, besides by the flowers being considerably smaller. The structure of the rhizome, however, is identical (Fig. 1); it is ascend ing or sometimes vertical, quite thick, and bears numerous leaf-scars from green leaves while scale-like ones are entirely absent. Slender secondary roots are developed beneath the leaves, and the primary root evidently dies off at an early stage. The leaves form an open rosette and the flower-bearing stem (St. in fig. 1) terminates the shoot; an axillary bud remains dormant through the winter and produces a rosette of leaves and an inflorescence during the next spring. Lateral branches develop often from the rhizome, especially when growing in Sphagnum bogs. While thus the Siberian plant differs somewhat

[1] Introductory Essay to the Flora Indica. London, 1855, p. 221.

from the arctic American, the several specimens which I have collected in the Spruce-zone of the Rocky mountains in Colorado agree in all respects with the Siberian plant.

FIGURE L.

1. *Saxifraga aestivalis* Fisch. and Mey., showing the rhizome, the basal leaves, and the base of the flower-bearing stem (St.); one third of the natural size; specimen from south coast of Coronation gulf, Cape Barrow. 2. Same species var. *Nelsoniana* (Don); a basal leaf; one third of the natural size, specimen from Herschel island. 3. *S. aestivalis;* a basal leaf; one third of the natural size; specimen from Siberia; Jenisei, Tolstoi Nos.

S. Nelsoniana Don.

This is by Engler referred to the preceding species as a variety; the leaf-blade (Fig. 2) resembles that of the Siberian plant but the petioles are much longer and the flowers relatively larger; the rhizome shows the same structure as described above.

S. Lyallii Engl. and **S. davurica** Pall.

These are both known from Alaska and adjacent islands; they exhibit the same habit as the preceding species but the leaf-shape is quite distinct.

S. hieraciifolia W. et K. and **S. nivalis** L.

These are also members of this section (*Boraphila*) but their habit is very different from that of *S. aestivalis*. The rhizome is relatively short but quite stout in the former, and secondary roots develop freely; the almost sessile leaves are arranged in a rosette surrounding the terminal, flower-bearing stem. Axillary buds sometimes develop rosettes contemporarily with the terminal, and several inflorescences may appear upon the same individual. Characteristic of these species of *Boraphila* is the early withering of the primary root.

Although quite frequent in the arctic region, *S. stellaris* L. var. *comosa* Poir. was not found by the expedition. I mention it in connection with the other species since it is quite an interesting plant showing some structures which recur in members of the section *Nephrophyllum*. The typical *S. stellaris* L. has an ascending or almost horizontal rhizome which, according to the substrate, may attain quite a considerable length; for instance, in specimens growing in wet moss the rhizome measures the length of about 18 cm. (specimens from Austria) and bears small, scale-like leaves subtending stolons of the same structure as the main rhizome. In these specimens the aerial leaves are so remote that no rosette is formed; however, in the northern plant a rosette i

developed from the centre of which the flower-bearing stem arises. The prim root dies off at an early state but becomes substituted by long, slender, second roots proceeding from the rhizome close beneath the rosette.

FIGURE M.

1. *Saxifraga stellaris* L. var. *comosa* Poir.; natural size; specimen from West Greenland. 2. Pe of same; enlarged. 3. A bulblet of same; enlarged. 4. A bulblet of *S. cernua* L.; enlarge 5. A germinating bulblet of same; enlarged. 6. *S. radiata* Small; natural size; specim from Herschel island. 7. Petal of same; enlarged. 8. *S. decipiens* Ehrh. from Cockbu point; natural size. 9. A leaf of same; enlarged.

An arctic variety of this species is the so-called *comosa* (Fig. M: 1, 2, 3) which most of the flowers are transformed into small bulblets. These bulble represent an important means of vegetative reproduction since they are able develop new individuals when separated from the mother-plant, thus remindi of *S. cernua* L. of the section *Nephrophyllum*. When the bulblet germinate it produces a short, ascending rhizome, terminated by a rosette of typical leave and an inflorescence bearing few flowers but many bulblets.

In the ion *Nephrophyllum* we meet with several species which develop bulblets upon the rhizome as well as in the inflorescence; this peculiarity was known already to Linnaeus when he described *S. granulata* "radice granulata." Afterwards the morphology of this plant has been described so very excellently by Irmisch (l.c. p. 190).

Among the arctic representatives of this section, *S. cernua* L. is the most frequent one. The rhizome is very short and the primary root must be of a very short duration since it constantly lacks in mature specimens. In this species bulblets (Figs. 1-5) are developed not only in the axils of the basal, green leaves but also in the inflorescence where they sometimes replace all the flowers.[1] Most frequently the bracts of the inflorescence subtend only single bulblets, corresponding to single flowers, but in some remarkable specimens gathered by James M. Macoun at Fullerton, Hudson bay, the bracts subtend numerous clusters of bulblets; in these vigorous specimens the inflorescence was profusely decompound instead of being a simple raceme as in the typical plant. On the other hand, in *S. debilis* Engelm., which Engler considers to be merely a variety of *S. cernua* (l.c. p. 107), these bulblets are totally absent.

The bulblets of the inflorescence are of a pink colour and they germinate freely when separated from the mother-plant. According to Warming,[2] slender stolons may also occur in this species, and the foliage of such stolons may consist of scale-like as well as of green leaves some of which may subtend bulblets.

S. radiata Small.[3]

This is *S. exilis* Stephan (1822) but the latter name has been rejected since there is a *S. exilis* Poll. of earlier date (1816). The species *S. radiata* (Fig. M: 6-7) resembles *S. sibirica* L. very much, but in *S. radiata* the stem is pubescent with glandular hairs intermixed; the basal leaves are merely 5-7-lobed, and the petals are very distinctly three-nerved. Bulblets occur in both species, mainly in the axils of the basal leaves, seldom in the inflorescence.

S. rivularis L.

This little species forms small cushions, but the primary root is substituted by a dense mass of filiform, secondary root he rhizome is very short and bears rosettes of leaves with terminal flowering as. When growing in loose, wet soil, or in moss, the rhizome may develop horizontal stolons (specimens from Camden bay), which bear typical green leaves. Bulblets occur also in this species as described and figured by Warming (l.c. p. 211), and by G. Lindmark.[4]

The section *Hirculus* comprises mostly Himalayan species, but one of these, **S. Hirculus** L., is also widely distributed throughout the northern hemisphere and reaches the polar regions in both Worlds. The arctic plant is low, the flowering stems reaching a height of only 6 cm. or less; it forms small and more or less compact cushions of numerous leaves, and several flower-bearing stems are produced on the same individual. There is no primary root in mature specimens but the profusely branched, subterranean shoots bear many filiform, secondary roots. The subterranean stem represents in these arctic specimens from Bernard harbour, Herschel island, etc., a horizontally creeping rhizome, about 7 cm. in length, slender, but woody, densely covered with remnants of withered leaves and branching freely; stolons with scale-like leaves are known to occur in the southern plant but I observed none in the numerous arctic specimens, which were examined. Vegetative reproduction is scantily represented by the arctic plant, since the branches of the rhizome are of a solid, woody structure, not permitting the secondary rosettes to become separated from the mother-plant.

[1] Compare: the author in Dijmphna-Expeditionen's Zoologisk-botan. Udbytte (l.c.).
[2] Saxifragaceae (Medd. om Grønland. København, 1912).
[3] North American Flora, Vol. 22, 1905.
[4] Bidrag till kännedomen om de Svenska Saxifraga-Arters yttre byggnad ach individbildning. Bih. K. Sv. Vet. Akad. Hdlgr. Vol. 28. Stockholm, 1902.

S. decipiens Ehrh., incl. var. **groenlandica** (L.) Lge., and **S. silenaeflo** Sternb.

These are the only members of the section *Dactyloides* which are know from arctic America; of these only the former was collected. *S. decipi* Ehrh. is the name adopted by Engler in his Monograph of the genus (l.c. p. 1 and the one used by the various authors, who have written on arctic botan for instance: Kjellman, Trautvetter, Lange, and others; recently, howev another name has been introduced, viz.: *S. groenlandica* L. by H. G. Simmon

S. decipiens is densely caespitose, and the primary root persists; it is slend but deep and ramifies freely; secondary roots, on the other hand, develop seldo There is no rhizome in the proper sense of the word, but numerous shoots devel from the crown of the root. Lindmark (l.c.) mentions that lateral shoots appe at an early stage and that they are developed from the axils of the lowermo leaves of the main shoot. The accompanying figure (Fig. M: 8) shows only small part of a large cushion; the shoots are densely clothed with withered leave and at the apex they bear several rosettes of fresh leaves surrounding the flowe bearing stems; since the development of secondary roots is very scant, the shoo do not, so far as I know, become separated from the mother-plant; thus t species is evidently not able to multiply by means of vegetative reproductio

While Engler (l.c.) has described a number of varieties of the species, Lan (l.c.) mentions only those occurring in Greenland, as follows: 1. *groenlandi* "2-4-pollicaris, dense pulvinata, glanduloso-pilosa, foliis trifidis, laciniis obtus subintegris;" 2. *uniflora*: "humilis, 1-3-flora, calyce nigro-glanduloso, ceteru ut 1, in quam sensim transire videtur, nam formae uni- et pluriflorae promisc leguntur;" 3. *Sternbergii*: "spithamaea v. ultra, laxius caespitosa, minus den glanduloso-pilosa; foliis palmato-trifidis, laciniis lateralibus bi-trilobis."

The section *Trachyphyllum* comprises types of very distinct habit; amon the arctic we meet with *S. bronchialis* L. and *S. tricuspidata* Rottb. which ha the same habit as *S. decipiens*; *S. aizoides* L. which in several respects reminds *S. Hirculus*, and finally the peculiar *S. flagellaris* Willd.

Of these, **S. tricuspidata** Rottb. forms large, compact cushions in the sam manner as *S. decipiens*, and the primary root persists, while secondary roo were not observed. In this species the flower-bearing stem is quite tall, reachi a height of about 10 cm. A specimen from Greenland, Pagtorfik, Noursoa peninsula, differs from the type by the shoots being very long, about 23 cm and the leaves remote, thus forming no rosettes.

S. bronchialis L. agrees with the former but besides the persisting prima root secondary roots are also present, developing freely from the subterranea stems. An interesting variety is *cherlerioides* Don, in which the lateral shoo are extremely short with the minute leaves crowded and thicker than in the typ it is a native of eastern Asia but has also been found in Alaska and adjacent island

Moreover, the species occurs also in the Rocky mountains, ascending abo 12,000 feet above sea-level in Colorado (Gray's peak), and specimens from th locality as well as from lower altitudes, for instance in Clear Creek canyo (10,000 feet), agree well with the Siberian plant; but when compared with th Alaskan plant (Kodiak, legit Walter H. Evans) there is some difference wi respect to the fruit; this is considerably larger in the Alaskan specimens bu otherwise the structure of the leaves and their position, being densely crowde is identical.

Some years ago Dr. Wiegand established a new species, *S. austromontan* founded upon specimens of *S. bronchialis* from the Rocky mountains, with th following distinction: "Differs from *S. bronchialis* L. in its more subulate, dark green leaves, with fewer ciliae near the apex; more slender pedicels, smalle

[1] Flora of Ellesmereland (l.c. p. 70).

white petals with purple dots above, and not unguiculate at the base; stamens shorter than the corolla; and smaller capsule with much shorter styles. It probably includes all of the so-called *S. bronchialis* from the Rocky mountains south of Alaska."

Some specimens which I have before me, collected by Mr. Crandall on Pennock's mountain ranch in Colorado (altitude 7,500 feet) agree exactly with the distinction pointed out by Dr. Wiegand,[1] but I do not believe these distinctive characters are sufficient for the establishment of a new species.

Professor Engler in his excellent monograph of the genus (l.c. p. 215) calls attention to the variability of *S. bronchialis* L. corresponding with that of *S. aspera* DC., of which the alpine form is more densely caespitose, and with the inflorescence few-flowered in contrast with the plant from lower elevations. Finally, if we compare *S. flagellaris* Willd. as represented in the north and south, we notice quite a prominent difference in the relative size of flower and fruit, the structure of the foliage, etc., but without feeling inclined to divide the species. From the experience I have had with *Saxifraga*, especially in the field, I should prefer to consider *S. austromontana* Wieg. as a form of *S. bronchialis* L., instead of an independent species.

S. aizoides L. Several complete specimens were collected by the expedition, "complete," because in several of the specimens the primary root was preserved. However, the arctic plant differs from the southern by its more condensed growth; quite compact cushions may be developed, measuring in width about 7 cm., not including the flowering stems. Among those from Bernard harbour some specimens are of quite diminutive size, barely 2 cm. high, and it is in such specimens that the primary root was present; it is relatively deep, but slender, and emits several branches; secondary roots develop freely from the subterranean stems. In the southern plant the stems are more spreading, in the manner of *S. Hirculus*, but typical stolons with scale-like leaves were not observed. In the arctic plant the leaves are much crowded and the shoot is quite profusely ramified; thus a cushion may be formed. Vegetative reproduction is secured by means of the lateral shoots, which may be separated from the mother-plant and, by their ability to develop secondary roots, new individuals may thus be formed.

S. flagellaris Willd.

This is one of the most interesting species of the genus. We find it in the polar regions as well as in the alpine, and exhibiting principally the same morphological structure. The arctic plant is generally of very low stature, the flower-bearing stem reaching a height of only 1½ to 3 cm. The shoot bears a number of fleshy leaves, glandular hairy especially along the margins, and these leaves form a small rosette resembling that of a *Sempervivum*. In spite of the very considerable material which I have examined, there is not a single specimen showing a persistent primary root; the root-system consists only of a number of secondary roots, developed from the basal internodes of the rosette. A single flower-bearing stem, bearing a few leaves and one or two flowers, terminates the shoot. Very characteristic of the species is the development of long runners above the ground, consisting of a single internode, reaching a length of about 10 cm., and terminated by a small spherical rosette of green leaves; these runners are developed in the axils of the rosette-leaves. When the fruit is mature the main shoot dies off and at this time, towards the end of the season, the rosettes borne on the runners have commenced to develop roots; as the runners die off with the mother-plant, these rosettes thus become independent individuals and repeat the growth of the mother-shoot. I do not know how long time these rosettes require to become mature to produce flowers, but judging from the size of various specimens which I collected in Nova Zembla, I presume they reach maturity in the third year.

[1] Bull. Torrey Bot. Club. Vol. 27, 1900, p. 388.

In comparing the arctic with the alpine plant, for instance with a series o specimens from the Rocky mountains of Colorado, the following deviation were noticeable. The flowering stem is taller, more leafy, and two to thre flowers may be developed; moreover the plant is more glandular hairy. Finally in some specimens from near the summit of James' peak (13,000 feet), a somewha remarkable structure occurs. They grew in somewhat damp soil associate with *Sieversia*, *Dryas*, *Actinella*, etc., and the flower-bearing stem reached height of about 15 cm., bearing about 7 flowers in a unilateral cyme; the flowe bearing stem was very leafy and several of the basal leaves above the rosett subtended runners of the usual structure. The rosette was not so compact as i typical specimens and, moreover, a subterranean stem-portion, about 5 cm. i length, extended from the rosette to a cluster of secondary roots; this stem portion bore some remnants of withered leaves and consisted thus of more tha a single internode. Some isolated young rosettes which grew near the flowerin specimens showed a similar elongated stem beneath the rosette-leaves, provide with a corresponding system of secondary roots at the lower end of the stem. A third type of specimens, however, explained this singular structure; it con sisted of a rosette of leaves with runners, but instead of being terminated by a inflorescence the main shoot had continued to grow above the rosette as vegetative shoot bearing several scattered leaves and terminated by a rosett of a more open structure than in the typical plant. In other words, the alpin *S. flagellaris* may remain at a purely vegetative stage for several years, but no as a single rosette, gradually increasing in size, as is the case in the arctic speci mens, but developing an erect, purely vegetative shoot, of which the apex assumes the shape of a rosette to produce flowers in the succeeding year, and stil depending on the same fascicle of secondary roots. The age of such specimen appeared to be not less than four years. The fact that none of the specimens examined possessed a primary root naturally indicates that they owed thei existence to rosettes of runners, which undoubtedly is the most common metho of reproduction in this species. However, capsules with ripe seeds are frequently to be found in alpine specimens, and even in Nova Zembla did I succeed in finding fully matured capsules with seeds.

The section *Porphyrion* to which **S. oppositifolia** L. belongs comprises only three other species: *S. biflora* All., *S. macropetala* Kern., and *S. retusa* Gouan Of these the two last are natives of the mountains of Middle and South Europe *S. biflora* is also a native of these mountains, but extends northward to Lapland and northern Russia.

S. oppositifolia, on the other hand, is widely distributed throughout the northern hemisphere and abounds in the polar regions. It is actually an under-shrub, since the profusely ramified branches above ground are woody. The long stems are mostly prostrate with the internodes more or less stretched, with the leaves opposite, and developing secondary roots quite freely. Erect, but very short, floral shoots are developed in the axils of the cauline leaves, and they bear only one flower, at first almost sessile, but distinctly pedicelled when fruiting. In very large, old specimens the posterior parts of the stem have frequently died off; thus the root-system is confined to secondary roots; but in smaller, younger specimens, the primary root may be preserved; it is slender, but quite deep, and bears several lateral branches.

An interesting variety, *Nathorsti*, was found by Dusén in East Greenland [1] and described as follows: "Laxe caespitosa; ramuli steriles breves, c. 3 cm. longi, sat dense foliati, foliis oppositis; ramuli floriferi elongati, 5-6 cm. longi, inferne glabri sursum sensim albopilosi, apicem versus dense pilosi, remote foliati, foliis medianis et supremis saltem alternis, rarissime oppositis; folia longiora et remotius ciliata quam in typo, rotundate acutata, usque ad 10 mm. longa et 3

[1] Bih. K. Sv. Vet. Akad. Hdlgr. Vol. 27. Stockholm, 1902, p. 35.

mm. lata; flores solitarii vel rarissime bini, majores quam in typo, colore variabiles, pallide rubro-violacei, pallide rosei vel albo-rosei; sepala fere triangularia, remote ciliata; petala ovalia vel oblongo-ovalia."

The diagnosis is accompanied by several figures showing the distinguishing characters very plainly. Gunnar Andersson and Henrik Hesselman have described two other types,[1] viz.: forma *reptans* and forma *pulvinata*. Of these, the former is appressed to the ground, forming loose mats, but of great width, until about 1 m. in diameter. In forma *pulvinata* the growth is very compact, and the width aggregates only to 20-30 cm.

Dryas L.

While *D. octopetala* L. and *D. Drummondii* Hook. have always been recognized as distinct species there has sometimes been expressed doubt about the specific validity of *D. integrifolia* M. Vahl. Kjellman,[2] who had the rare opportunity to observe *D. octopetala* and *D. integrifolia* at the same station on the Asiatic coast of Bering strait at Konyam bay, felt convinced that they represent two distinct species. Nathorst,[3] who also found them growing together, at Cape York on the northwest coast of Greenland, observed moreover a form intermediate between both which he named *D. integrifolia* forma *intermedia;* in this form the leaves varied from being dentate only at the base to dentate along the whole margin from base to apex. This author felt inclined to consider this intermediate form as a hybrid, inasmuch as the two species keep remarkably constant, even when distributed over large areas. The forma *intermedia* has since also been reported from Northeast Greenland, viz.: Scoresby sound by Hartz,[4] who has figured an interesting series of leaves of typical *D. octopetala*, of the forma *intermedia*, and of *D. integrifolia*.

The specimens from Port Epworth harbour represent the forma *intermedia*, but in these specimens the dentate leaves are very few in proportion to the entire ones, and the specimens are better referable to *D. integrifolia* than to the other.

Sieversia glacialis R. Br.

A few specimens in fruit were collected of this very rare species, the stem reaching the height of fifteen cm.; by the styles being pilose the species is readily distinguished from *S. Rossii* R. Br.

Potentilla palustris (L.) Scop.

Two vegetative shoots were collected with relatively large leaves, the length of the leaflets being about 2 cm. and the width about 1 cm.

P. fruticosa L.

The specimen from Port Epworth, collected in the month of July, is quite a little shrub 17 cm. high, with several stout branches, with its leaves distinctly petiolate, and with the floral peduncles attaining a length of about 3 cm.; the flowers are large and as well as the leaves larger than those I have seen in the alpine region of the Rocky mountains in Colorado.

[1] Spetsbergens Flora, l.c. p. 25.
[2] Asiatiska Beringsundskustens Fanerogamflora. Vega Expedit. vetensk. arbet. Stockholm, 1882, p. 527.
[3] Botaniska anteckningar från nordvestra Grönland. Öfvers. Kgl. Svenska Vet. Akad. Förhdlgr. Stockholm, 1884, p. 24.
[4] Fanerogamer og Karkryptogamer fra Nordøst-Grønland. Medd. om Grønland, XVIII. Kjøbenhavn, 1895, p. 320.

PAPILIONACEAE.

Lupinus nootkatensis Donn var. **Kjellmanii** Ostf.

The species is perennial with a deep, strong primary tap-root bearing large rosette of leaves surrounding a tall flower-bearing stem, the tallest specim measuring about 24 cm. in height, the flowering raceme itself about 8 cm. fruiting specimens the large legumes are densely villous, and about 5 cm. length.

Astragalus [Tourn.] L.

The two species of *Astragalus* show a very different habit. In *A. alpin* the primary root persists but it is very slender; the aerial shoots are quite lo but very slender, prostrate, and profusely branched, bearing several leaves a a terminal, long-pedunculate inflorescence. Some few secondary roots develo from the nodes, and tubercles were found on some of the lateral roots.

In *A. aboriginorum*, on the other hand, there is a very strong and thic primary root, often branched and crowned with numerous, compact clusters persisting internodes with scale-like le ves, supporting leafy shoots and flowe bearing stems; root-shoots ab

As may be seen from (Part A, Plate X), the arctic specimen *A. aboriginorum* differs in sev respects from the prairie plant described a figured by Hooker (Fl. bor. Am.), but Mr. Marcus Jones, to whom specime were sent for identification, kindly informed me that the arctic material repr sented the typical plant.

With regard to the systematic position of this species Hooker (l.c.) stat that the perfect fruit which was unknown to Dr. Richardson has now been se in abundance, and proves the species to be a *Phaca*, rather than an *Astragalu*

Phaca frigida L.

In specimens from Bernard harbour, collected in the month of August, t racemes with fruit, not fully matured, measure 15 cm. including the pedunc while in bloom the stem above ground measures only about 8 cm. in heigh The primary root is long and slender and the capillary, lateral roots bear tube cles. As in the plant from Nova Zembla, which I have described and figure (Dijmphna Expedition l.c.), the aerial shoots develop from the axils of scale-lik leaves borne upon persisting basal internodes; thus a pseudo-rhizome is al possessed by this plant.

Oxytropis Roaldi Ostf.

Having been published in Christiania,[1] and perhaps not being readil accessible to the reader, I herewith insert the diagnosis as written by Mr. Oste feld; it reads as follows:

"Scapigera, usque 20 cm. alta, multiceps; stipulae alte petiolares, alba membranaceae, longe ciliatae, pars libera uninervis, e basi dilatata linear foliola 7-8-juga, lancelato-ovata, adpresso niveo-pilosa; scapi foliis longior pilis subadpressis vel subpatulis instructi; inflorescentia subcapitata, 5-1 flora; bracteae lineari-lanceolatae, calycem subaequilongae; calyx tubulos campanulata, dentibus triangularibus tubo triplo brevioribus, pube nigr pilisque longioribus albis instructa; corolla calyci dimidio longior, violace purpurea; legumen (altum) ovato-oblongum, recte, acuminatum, membranace chartaceum, ca. 12 mm. longum, uniloculare vel partim semi-loculare, pub breve griseo, calycem subduplo superans. Herschel Island."

[1] Vascular plants collected in arctic North America (King William Land, King Point and Hersch Island) by Gjöa Expedition 1904–1906. Vidensk. Selsk. Skrift. Christiania, 1910.

Characteristic of the species of *Oxytropis* collected on the expedition is the caespitose growth with numerous leaves forming compact cushions, especially in *O. nigrescens* and *O. arctobia* The primary root persists; it is quite long and relatively thick, frequently supplemented by secondary roots of almost the same length and thickness. Numerous aerial shoots with the very short internodes completely hidden by the crowded, withered leaf-sheaths, stipules, rises from the crown of the root, and these shoots are terminated by rosettes of, leave surrounding the central flowering stem overtopping the leaves, as in *O. foliolosa*, *O. campestris* and *O. Rouldi;* or the peduncle of the inflorescence is so short that only the flowers themselves are raised, and only slightly so, above the foliage, as in *O. nigrescens* and *O. arctobia*. The habit of these two species is thus identical with that of *Trifolium nanum* from the alpine region of the Rocky mountains. A specimen of *O. nigrescens* from Camden bay consists of a compact cushion measuring 18 cm. in diameter; the largest of *O. arctobia* measured 12 cm. in diameter. Common to the two species of *Oxytropis* and the *Trifolium* mentioned above is the two-flowered inflorescence, while in the other species there are several flowers forming a head or a short, more open raceme.

Hedysarum Mackenzii Rich. shows the same habit as *Oxytropis campestris*, but the flowering stems are much taller and branched, specimens from Bernard harbour measuring 28 cm. in height; the inflorescence is racemose.

Characteristic of these arctic Papilionaceae is thus the persisting primary root; in most of these the growth is caespitose owing to the profuse development of aerial shoots of which the basal internodes persist and from the leaves of which new shoots arise, bearing leaves and flowers, and dying down to the ground at the end of the season, leaving only the lowermost part to persist and represent the ramification in the manner of a pseudo-rhizome.

EMPETRACEAE.

Empetrum nigrum L.

Several specimens were collected on tundra, with flowers and fruit; the branches showed the typical growth of the species and were quite long, reaching 30 cm. in length.

ONAGRARIEAE.

Epilobium latifolium L.

The tallest flowering specimen is from Cape Barrow; it measures 20 cm. in height, and several stems are developed from the woody, thick, primary root; as to the size of the flowers, the dried petals measure 2.2 cm. in length and about 1 cm. in width. The leaves are lanceolate, quite long, and relatively narrow. In specimens from Wollaston land the flowering stems are much shorter, only 9 cm. in length, and the leaves are short but very broad, oval in outline. While thus the primary root persists and develops as a strong vertical root, the basal subterranean stem-portions persist also and increase in thickness; upon these buds become developed which give rise to the aerial, floral shoots; thus we have in this plant a pseudo-rhizome with the primary root persisting and increasing quite considerably in thickness. Among the numerous specimens collected there was no indication of reproduction by means of root-shoots.

E. angustifolium L.

The Fire-weed is so widely distributed in the arctic regions that it is even circumpolar, but it is nowhere as abundant in the polar regions as farther south, throughout the entire northern hemisphere. And farther south it is especially

abundant in clearings and newly burned lands. It is also called Willow-her on account of the seeds bearing a tuft of long hairs through the help of whic the plant is readily disseminated over areas of great extent. However, th species possesses also another means by which its dispersal is effected, namel by the long horizontal roots developing root-shoots; these roots with bu may persist for many years in the soil in a dormant state waiting for the oppo tunity favourable to their farther development. And this opportunity is th cutting down or burning of the forest. This is a fact so well known that it hardly worth mentioning but, among the many reports that have been give about the sudden and abundant appearance of the species, one might be cit here which is quite interesting. Mr. I. W. Chickering [1] writes: "In northweste Maine, on a tract of land of some 4,000 acres, over which lumbering operatio had been carried on some years ago, leaving a tangled mass of limbs and unde brush a fire broke out June 8th and swept over this entire tract, lasting for tw weeks, burning with such fury that it was almost impossible for the stage t travel along the road. A new vegetation began to start in three weeks after th fire, and the whole region of 4,000 acres was covered with *Epilobium angust folium* as far as the eye could reach, over hill and valley, ridge and interval wa one mass of colour from the Fire-weed." This sudden and so abundant appea ance of the plant must necessarily have been caused by the rapid developme of root-shoots, which thus were in the soil in the state of buds waiting for th opportunity. From the writings of Irmisch [2] we have learned about this pla that it often reaches the flowering stage in the first year. But, of course, th vegetation mentioned by Mr. Chickering could not possibly owe its appearan to seeds, three weeks after the fire. But Irmisch describes also the root-syste and this author made the interesting observation that the primary as well a the secondary roots of the young seedling develop buds freely which sometim give rise to new plants in the succeeding year. The wide distribution in th north of the species evidently depends on its dissemination by the wind; i persistence, on the other hand, it owes to the development of root-shoots.

UMBELLIFERAE.

Bupleurum americanum C. et R.

The only arctic representative of the genus and in no particular morph logically distinct from its numerous, more southern, congeners among th perennial forms. The primary root persists as a relatively slender tap-ro crowned with a rosette of long, narrow leaves and a few or only a single flowe bearing stem, somewhat taller than the leaves; the tallest specimen measur about 14 cm. in height.

Selinum cnidiifolium Turcz.

A few flowering specimens of this very conspicuous plant were collected o Herschel island; it shows the same habit as *Pachypleurum*, but is more robus the stem taller, about 20 cm., and the ample, basal leaves deeply cut; the large umbel measured 10 cm. in diameter.

ERICACEAE.

Ledum palustre L.

In all the specimens collected the leaves are remarkably short, sometim barely 1 cm. in length, and very narrow; the inflorescence is also much small than in the typical plant. Some of these specimens may be referable to th variety *decumbens* Ait., but in others the stems appear to have been erect, an attaining a height of about 23 cm.

[1] Bot. Gazette Vol. 9, p. 193. Chicago, 1884.
[2] Botan. Zeitung, Leipzig, 1857, p. 459.

Rhododendron lapponicum (L.) Wahlenb.

Some of the specimens are quite bushy but with the stems more or less prostrate; as to the foliage and the flowers these agree in all respects with those of the Greenland plant.

Kalmia polifolia Wang.

Seems to be very rare as only two small specimens were collected; the aerial branches are erect, about 6 cm. high, and are mostly one-flowered; the leaves are short and very narrow, and the specimens are even more reduced in size than those which I have observed in the high mountains of Colorado above timber line.

Loiseleuria procumbens (L.) Desv.

Only two specimens were found on the south coast of Coronation gulf, in Epworth harbour. The denuded, twisted stem is quite thick and prostrate, bearing at the apex many ascending branches with leaves and flowers of the typical structure.

Cassiope tetragona (L.) Don.

Common, and collected at several stations; it varies much in height; from 8 to 22 cm.; the smallest specimens are from Camden bay; in these the prostrate stem bears numerous ascending, crowded shoots with many flowers. Otherwise the plants resemble those from Greenland.

Arctostaphylos alpina (L.) Spreng.

All the specimens collected show the characteristic habit of the species; in fruit-bearing specimens from Bathurst inlet (August 25th) the leaves are of normal size, measuring about 3 cm. in length and 1.2 cm. in width.

VACCINIACEAE.

Vaccinium uliginosum L.

While all the specimens represent the variety *microphyllum* Lge., those from Bernard harbour are the most peculiar, the length of the leaves averaging only about 5 mm.

V. Vitis-idaea L. var. **pumilum** Hornem.

The very small specimens agree exactly with the plant as it is developed in other arctic countries; although collected as late as in August, the specimens were all in bloom.

PRIMULACEAE.

Androsace Chamaejasme Host.

The habit of this interesting little plant is the same as that of specimens from the alpine region of the Rocky mountains. It actually represents an undershrub with two types of shoots. The persisting, but very slender, primary root is crowned with a dense rosette of leaves from the axils of some of which long slender stolons develop. These stolons are completely above ground and consist of one or several stretched internodes the foliage of which is in the shape of rosettes, but only the apical develops an inflorescence, a scape with a few-flowered umbel, or it remains purely vegetative, giving rise to a secondary

FIGURE N.

Androsace Chamaejasme Host.; a flowering specimen, showing the primary root and t
stolons above ground terminated by rosettes of leaves and inflorescences; natural size; specim
from Bernard harbour.

group of sessile rosettes. The rosette dies off after the first flowering, becomi
replaced by the secondary rosettes. The root-system is thus poorly represent
and secondary roots are very scarce; when such develop, they proceed, one
two together, from the nodi of the stolons. There are thus apparently two typ
of shoots in this plant, viz.: the stolons with stretched internodes, and the a
of the rosette, consisting of extremely short internodes with crowded leav
However, as a matter of fact, it is the same shoot, an axis of the same orde
which thus becomes modified in structure according to its function, to d vel
in the manner of a horizontally creeping stolon, with the uppermost inte od
becoming shortened so as to produce a rosette with a terminal inflorescence.

Primula borealis Duby.

Kjellman,[1] who has offered so many and most excellent contributions
the knowledge of the life-history of arctic plants, describes the over-winteri
buds of *Primula nivalis*.

In this species the over-wintering bud consists of several fleshy, scale-li
leaves surrounding a series of very small leaves which in the following seas
will develop into green assimilating leaves; in the centre of the bud an inflore
cence is already formed, and this structure is to be observed at the commenc
ment of the winter. The material of *P. borealis* Duby collected on the expediti
contains numerous specimens with an old withered scape from the year previou

[1] Ur Polarväxternas lif. Stockholm, 1884.

as well as a scape of the year of collection, bearing an umbel of flowers. In the axil of one of the innermost leaves of the rosette the bud to winter over is already visible; thus these two arctic species show the same method of hibernation. Furthermore, in both species the rhizome is vertical but extremely short, and there is no trace of the primary root; the root system consists of several long secondary roots developed from the basal internodes of the subterranean stem or rhizome.

Dodecatheon frigidum Cham. et Schl.

As in the *Primulae* described above, there is an over-wintering bud situated in the axil of one of the innermost leaves of the rosette, and of the same structure. But *Dodecatheon* possesses a very distinct, well developed rhizome which is horizontally creeping, quite thick, and reaching a length of up to 4.5 cm. Numerous long, fleshy, sparingly branched, secondary roots develop from the lower face of the rhizome.

Douglasia Lindl.

According to Bentham and Hooker only four species are known, three being natives of this continent, the fourth of the European Alps, generally called *Aretia vitaliana* Gaud. The genus belongs to the section *Primuleae*, and its nearest ally is *Androsace*. Gray (Synopt. Fl. l.c.), describes four species from this country: *D. nivalis* Lindl., *D. arctica* Hook , *D. laevigata* Gr., and *D. montana* Gr. Of these, *D. nivalis* is known only from near the sources of the Columbia at an elevation of 12,000 feet (Douglas), while *D. arctica* has been found on the arctic seashore between the Mackenzie and Coppermine rivers (Richardson), and Red mountain, Yukon valley (M. W. Gorman, 1899); since then it has been reported from King point, on the Arctic coast, Lat. N. 69° 6′, Long. W. 137° 40′, by the Gjöa expedition, and from between Herschel island and the Mackenzie river delta by I. O. Stringer.

D. arctica forms small compact cushions of erect or ascending woody stems, densely covered with the appressed linear leaves and terminated by the flowers which are arranged in a small umbel. None of the specimens examined had the root-system preserved.

GENTIANACEAE.

Gentiana arctophila Griseb. and **G. propinqua** Richards.

They both are annuals and of exactly the same habit, viz.: a small rosette of opposite leaves, a central, terminal, flower-bearing stem with one or two pairs of opposite leaves subtending single flowers, and furthermore, one or two pairs of one-flowered peduncles much shorter than the main stem, developing from the axils of the innermost pairs of leaves of the rosette. They resemble each other very much but may, nevertheless, be readily distinguished by means of the structure of the corolla which, according to Grisebach,[1] shows the following characters: "Corollae 4, rarius 5-fidae coeruleae lobis ovato-lanceolatis acuminatis cuspidatis setula coronatis et margine hinc setulosis tubo obconico basi angusto fere 2-plo brevioribus in *G. propinqua*,"—while "corollae 4 fidae coeruleae lobis triangulari-ovatis basi superincumbentibus acutis cuspidatis setula coronatis margine nudis tubo sensim ampliato basi lata 3-plo brevioribus in *G. arctophila*."

Most of the specimens are very small; the height of *G. arctophila* averages from 6 to 7 cm., and from only 2 to 6 cm. in the other.

[1] Genera et species Gentianearum. Stuttgart, 1839.

Pleurogyne Esch.

While *P. rotata* Griseb. has been recorded from quite a number of stat
on this continent, viz.: Labrador and Hudson bay to the high-northwest co
Kotzebue sound, etc., and the Rocky mountains south to lat. 39°, *P. carinth*
Griseb. has not with certainty been observed here; Gray and Macoun h
credited a variety *pusilla* Gray to Labrador and the alpine region of the W
mountains of New Hampshire (Pursh), but according to Robinson and Ferna
the American *P. rotata* includes *P. carinthiaca* var. *pusilla*, which by Macoo
has been reported from Anticosti and some few stations in Quebec. Meanw
both species were collected by the Canadian arctic expedition, and since
carinthiaca has been confused with the other, some brief notes on their distinct
characters may be appropriate. Both were described by Grisebach,[3] v
"*P. rotata*, foliis lanceolatis linearibusque, sepalis lanceolato-linearibus corol
aequantibus, ovario acuto, seminibus suturalibus," and "*P. carinthiaca*, fo
ovalibus oblongisque, sepalis ovatis corolla duplo brevioribus, ovario obtu
seminibus prope suturam insertis." A specimen from Bernard harbour of
carinthiaca has been drawn on Plate XI, fig. 3 (Can. Arct. Exp., Vol. 5, pt.

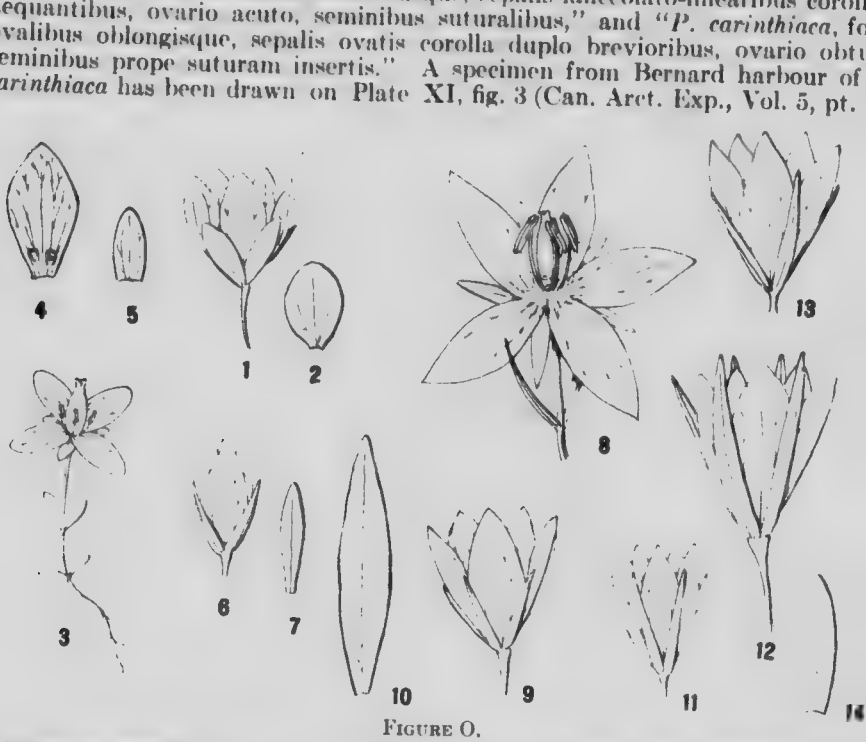

FIGURE O.

1. *Pleurogyne carinthiaca* Griseb.; a flower; one and two-thirds times natural size; specimen fr
Almagell, Valais, Switzerland. 2. Stem-leaf of same specimen; one and two-thirds tin
natural size. 3. Same species; specimen from mouth of Mackenzie river; natural size.
Same species; a corolla-lobe; one and two-thirds times natural size; specimen from Berna
harbour. 5. Calyx-lobe of same specimen; one and two-thirds times natural size. 6. *Pl*
rogyne rotata Griseb.; a flower; one and two-thirds times natural size; specimen from Bat
urst inlet. 7. Stem-leaf of same specimen; one and two-thirds times natural size. 8. Sa
species; an open flower; specimen from Blagowjestschensk, Amur; one and two-thirds tim
natural size. 9. A closed flower of same specimen; one and two-thirds times natural siz
10. Stem-leaf of same specimen; natural size. 11. Same species; a flower; specimen fro
near Twin lakes, Leadville, Colorado; altitude 9,265 feet; one and two-thirds times natur
size. 12. Same species; a flower; one and two-thirds times natural size; specimen fro
Churchill, Hudson bay. 13. Same species; a flower; one and two-thirds times natural siz
specimen from the same locality. 14. A stem-leaf of same specimen; natural size.

[1] Gray's New Manual of Botany. 1908, p. 659.
[2] Catalogue of Canadian Plants, Part II. Montreal, 1884, p. 325.
[3] Genera et species Gentianearum; Stuttgart, 1839, p. 309.

and another specimen of the same species from the Mackenzie river delta is figured in the accompanying text-figure (Fig. O) beside a specimen from Switzerland (Fig. O: 1). With the only exception that the flowers in the American plant are tetramerous, but pentamerous in the European, the structure of the flower and foliage agrees very well with that of the European; and although *P. rotata* varies somewhat with respect to the structure of the flower: tetramerous or pentamerous, the calyx-lobes being shorter or longer than the corolla, and the leaves varying in length and width, no transitional forms have been observed so as to make the identification uncertain. *P. rotata* Griseb. is generally a taller plant with the leaves relatively much longer and narrower than those of the other species, and the narrow calyx-lobes constitute also a good character.

As stated above, the flower varies from tetra-to pentamerous, the former observed in the specimens from Bathurst inlet; in Greenland both types of flowers occur, and in a large series of specimens from Amur most of the flowers were pentamerous; pentamerous flowers are also characteristic of the plant from Colorado. With regard to the plant from the Hudson bay region, some small individuals from Fort George have only tetramerous flowers while others of normal size have all the flowers pentamerous; in very tall specimens from Alberta the flowers are constantly pentamerous. The calyx-lobes vary considerably in length as may be seen from the figures (Fig. O: 6, 8, 9, 11, 12 and 13); for instance in some specimens, collected growing together (Figs. 12-13), the lobes may be longer than the corolla, or considerably shorter than this. But in these deviating forms no approach to the floral structure of *P. carinthiaca* can be detected.

These two species are strictly annual and of low stature; the tallest specimens of *P. rotata* measures 10 cm. in height, while *P. carinthiaca* does not reach more than from 2 to 3 cm.

POLEMONIACEAE.

Phlox Richardsonii Hook.

Densely caespitose, forming large cushions of a diameter up to 18 cm. The primary root persists; it is deep, woody, and branches very little; the flower-bearing shoots are quite long and woody, bearing numerous crowded rosettes of small leaves at the apex, surrounding the single, almost sessile, relatively large flowers. The plant thus represents an undershrub.

Polemonium caeruleum L. var. **villosum** (Rud.) Brand.[1]

Measured from the crown of the very long and slender persisting primary root, the prostrate stem above ground reaches a length of up to 25 cm., and stems of that length are in their fourth year of age. The plant is stoloniferous, and the development of the shoot may be studied from smaller, younger specimens. During the first season a rosette of leaves develops; in the second year a terminal inflorescence appears, borne upon a long (about 10 cm.), erect peduncle, naked, or bearing a single leaf supporting a secondary few-flowered inflorescence. From the axil of one of the rosette-leaves a long stolon develops bearing numerous scale-like leaves and terminating in a rosette of green leaves from which the ramification continues as described. The vegetative reproduction is secured, moreover, by long, slender stolons proceeding from the axils of the scale-like leaves; thus the plant is able to spread over an area of quite considerable size.

[1] Polemoniaceae, in A. Engler, Das Pflanzenreich. Berlin, 190..

FIGURE P.

Polemonium caeruleum L. var. *villosum* (Rud.) Brand, showing the stolons, and the base an aerial shoot; two-thirds of the natural size; specimen from Herschel island.

P. boreale Adams.

In this species the height of the flower-bearing stem is only about 6 cm but the total length of the shoot developed from the crown of the root may measure a length of up to 20 cm. Otherwise the structure of the root and the ramification of the shoot agree with those of the preceding species.

BORAGINACEAE.

Mertensia aritima (L.) S. F. Gray.

The primary root is fleshy, quite thick, and reaches a considerable length —over 30 cm. From the crown of the root arises a large complex of shoots which ramify freely, forming open rosettes and ascending, very leafy, flower-bearing stems. In the specimens from Martin point, Alaska, the plant forms large open cushions measuring about 20 cm. in diameter.

Myosotis silvatica Hoffm.

It is rather surprising to see an herb like this reaching a height of 2 cm. at a latitude of 69° 35′ N.; the specimens were collected with flowers and young fruits in the month of August.

SCROPHULARIACEAE.

Castilleja pallida (L.) Kunth.

The tallest specimens are from the south coast of Coronation gulf; they measure about 22 cm. in height. The plant is perennial but the primary root, although quite thick, is not very deep owing to the profuse development of long, thick lateral roots. There is no rosette of leaves, but a cluster of shoots arises from the

crown of the root, and most of these shoots are flower-bearing, terminated by the dense, capitate inflorescence; usually some few purely vegetative shoots develop from the crown of the root, but these do not grow any further, nor do they winter over. The vegetative reproduction is effected by means of the persisting stem-bases with their auxillary buds, thus representing a pseudo-rhizome.

Pedicularis [Tourn.] L.

With respect to the habit of the species collected, four types are represented. They are all perennial, and the primary root persists, but is developed to quite a different extent. *P. arctica*, *P. lanata*, and *P. hirsuta* represent one type in which the primary root is very thick, wrinkled, and commences to branch at a depth of about 2 cm.; it then develops a few lateral roots, equaling the primary in length, and of almost the same thickness. There is no rhizome, and a compact rosette of green leaves is borne at the crown of the primary root. In the centre of the rosette the flower-bearing stem develops. In *P. sudetica*, on the other hand (Fig. Q), there is a subterranean, horizontally creeping stem which is

FIGURE Q.

Pedicularis sudetica Willd., showing the horizontally creeping rhizome, a stolon, some leaves, and the base of the flower-bearing stem; natural size; specimen from Camden bay.

quite thick. Secondary roots develop here and there; they are fleshy but r slender, long, and branch very little. Besides that the apex of the subterra stem develops into a floral shoot, as shown in the figure, some lateral sh develop also, and these remain vegetative for at least two seasons. By structure of the stem and root-system *P. sudetica* is readily distinguished the three species mentioned above. A third type is shown by *P. verticilla* very conspicuous plant with the several flower-bearing stems measuring a 18 cm. in height. In this species the habit, i.e. structure of root-system shoots, agrees with that of *Castilleja*, described above. Very characterist the arrangement of the stem-leaves, forming several whorls and subter axillary, almost sessile clusters of flowers.

In *P. lapponica* and *P. capitata* the primary root is long, but remains slender, and persists only for a few years. Long, creeping stolons develop the axils of the basal stem-leaves, and when separated from the mother p these stolons give rise to new individuals. When I collected *P. lapponic* Greenland, I observed that the flowers are very fragrant, exhaling a perf similar to that of the Lily of the Valley; otherwise the species of *Pedicularis* not at all fragrant. In some of the European species the ramification of shoot has been described as being monopodial; owing to the present mat being dried, and all being specimens in full bloom, I was unable to study particular point in the stem-structure.

SELAGINACEAE.

Lagotis glauca Gaertn.

This has a long (about 10 cm.), creeping, fleshy rhizome, bearing m long, slender, sparingly ramified, secondary roots. A flower-bearing s develops at the apex of the rhizome, surrounded by a few (mostly only t green leaves, but by many withered leaf-sheaths from the preceding years. plant shows to some extent the same habit as *Chionophila* and, judging from well preserved, dried specimens, the floral stem appears to be lateral; in o words, the shoot represents a monopodium as in *Chionophila*.

According to Hooker (Fl. bor. Am.) the variety *Stelleri* is the plant collec on the expedition, but Hooker considered this a species, not a variety; and calls the genus *Gymnandra*. The specific diagnosis reads as follows:

"*G. Gmelini* (Cham. et Schl.); foliis radicalibus subrotundo-aut elonga ovatis basi parum attenuatis obtusiusculis grosse inaequaliter crenatis, stam bus labio superiore duplo brevioribus, stylo illo breviore. *G. ovata* Wi *G. reniformis* Willd. *G. borealis* var. Pallas. *Lagotis glauca* Gaertn. *Bar gymnandra* Willd. Hab. Unalaschka Cham."

"*G. Stelleri* (Cham. et Schl.); foliis radicalibus oblongis utrinque infra v magis attenuatis acutis inaequaliter obtuse serratis, staminibus fere longitud labii superioris, stylo illo longiore. *G. minor, G. dentata, G. gracilis* Willd *borealis* Pall. Hab. Bay of St. Lawrence. Chamisso."

PLANTAGINACEAE.

Plantago lanceolata L. var.

Characteristic of this arctic variety is the small size of the leaves and flo scapes; the latter measure generally only 5 cm. But it agrees with the typi plant so far as concerns the structure of the shoot being monopodial, and by t development of the primary root as a deep, thick tap-root, measuring in so specimens about 10 cm., and bearing several, but thin lateral roots.

VALERIANACEAE.

Valeriana capitata Pall.

This has a long, about 7 cm., creeping rhizome with many slender, unbranched, secondary roots, while there is no trace of the primary root, at least not in fully matured individuals. There is no rosette of leaves, only a pair of basal ones, and the aerial stem seldom bears more than two pairs.

CAMPANULACEAE.

Campanula uniflora L. (Fig. R).

Some remarkably tall specimens measuring 22 cm. were collected on the south coast of Coronation gulf; all the other specimens are of normal size, and much smaller. The vegetative structure is quite interesting. As shown in the figure, the primary root is developed as a relatively large, wrinkled tap-root,

FIGURE R.

Flowering specimen of *Campanula uniflora* L., showing the large primary root, the subterranean stems terminated by rosettes of leaves and flower-bearing stems; the specimen from Bernard harbour.

bearing several shoots at the crown. These shoots are slender, and their s terranean part bears small, scale-like leaves, while toward apex small rose of green leaves appear, surrounding the flowering stems. As the main, i.e. primary, root is wrinkled, indicating that it is contractile, the crown of the r becomes gradually pulled deeper and deeper down in the ground, at the sa time as the subterranean parts of the stems increase in length. In young sp mens the subterranean stems are thus much shorter, sometimes barely visi the crown of the root being close to the surface of the ground.

COMPOSITAE.

Erigeron grandiflorus Hook.

A robust species, the heads measuring 4 cm. in width, borne on simp leafy stems, about 12 cm. in height. A large rosette of leaves is develop from the short, thick, ascending, subterranean stem portion, and the prima root is deep, but rather slender; similar long secondary roots develop from subterranean internodes. In large specimens several subterranean ste terminated by leafy rosettes, were developed from the crown of the sa root. A corresponding structure recurs in *E. compositus* Pursh, but in t species the subterranean stems are more numerous; thus the rosettes fo cushions of considerable width.

E. uniflorus L.

In well developed specimens the habit may vary from densely caespito i.e. with a rosette of leaves borne upon a very short, erect, subterranean ste bearing numerous strong, secondary roots, to a more open growth, the su terranean stem being horizontally creeping, measuring about 7 cm. in leng and terminated by a few aerial shoots with only a few basal leaves. Most of t species belong to the variety *pulchellus* Fr.

E. alpinus L.

Only a single, but well developed specimen of this, on this continent so ve rare species, was found at Port Epworth. As pointed out by Lange (Consp. Groenl.), it may be readily distinguished from *E. uniflorus* L. by "Pericli pilis non vel obsolete articulatis, floribus femineis exterioribus ligulatis, interio bus oblique tubulosis."

Concerning the habit of the plant, this differs also to some extent from th of the preceding species. The basal leaves form a compact rosette, with numero strong secondary roots; from this rosette nine erect flowering stems were deve oped, all simple, and attaining a height of about 16 cm.

Antennaria alpina (L.) R. Br.

Only a few specimens were collected and they represent the variety which the leaves are hairy on both faces. Lange [1] has called this variety *cane cens*, and it has been found in Greenland, Scandinavia, and in the boreal regio of this continent, besides in the alpine region of the Rocky mountains, in Colora for instance.

A. candida Greene.

The specimens upon which Greene established this species came from M Rainier, Washington, at an elevation of 9,000 feet, and the diagnosis reads follows:[2]

[1] Flora Danica Fasc. 47. Tab. 2786 (1869).
[2] Greene, E. L. Leaflets, Vol. 2. Washington, 1910-12, p. 151.

"The numerous very leafy surculi upright and their leaves not rosulate, but suberect, ½ inch long more or less, obovate-spatulate, clothed densely with close snowy-white tomentum: flowering stems rising 1 to 2 inches above the cushion of leafy surculi, slender with their small leaves as white-whooly as other parts; heads in fertile plant 3 to 5, closely congested; proper scales of involucre wholly concealed by the white indument, their translucent tips from oval and obtuse in the outermost to oblong, and in the innermost to lanceolate and acute or acuminate; sterile plant not known."

The material from Bernard harbour shows an ascending, creeping rhizome with numerous long, slender, unbranched roots; the foliage forms dense rosettes but so closely crowded that the leaves, as described, are mostly erect. The snow-white tomentum on both faces of the leaves renders the species very distinct from *A. alpina* and its allies.

Matricaria inodora L. var. **grandiflora** (Hook.) Ostf.

This is the variety which Ruprecht [1] has described under the name "*phaeocephala*." It is the arctic representative of *M. inodora*, and while the typical, southern plant is annual or biennial, the arctic form is perennial. The specimen from Herschel island measures about 23 cm. in height, and only a few specimens bore two heads on the same stem. The subterranean stem-portion is erect, but very short, densely covered with remnants of old leaves, and the root system consists of long, slender, fibrous roots. Several rosettes of green leaves may occur at the base of the aerial stem, and the habit of the plant is actually that of a perennial.

Chrysanthemum integrifolium Rich.

Characteristic of this species are the short, linear leaves forming very compact rosettes; the flower bearing stems are monocephalous. The subterranean, vegetative organs consist of several ascending stolons arising from a common base, evidently the crown of the primary root which, however, had faded away in the material collected; the only roots still in existence are long, slender, secondary ones, proceeding from the internodes of the stolons.

Artemisia vulgaris L. var. **Tilesii** Ledeb.

Some very tall specimens were collected on the south coast of Coronation gulf, which measured a height of 40 cm., including the about 12 cm. long panicle. The aerial shoots are developed from a complex of stem-bases with numerous, thin, secondary roots, representing a pseudo-rhizome.

A. Richardsoniana Bess. and **A. hyperborea** Rydb.

These have a persisting, deep and thick primary root, from the crown of which ascending subterranean stems arise, terminated by compact rosettes of leaves, surrounding the flower-bearing stems. These subterranean stems vary much in length, averaging about 6 cm. in the latter species. According to the diagnosis the hairy covering of the stems and leaves is somewhat different in these species, which, however, may depend on the character of the soil where they were collected, the former inhabiting a gravel-tundra, the latter, on the other hand, sand-dunes and sandy slopes. With respect to *A. Richardsoniana* Bess., this is described by Gray [2] as follows: "A span to near a foot high, with rather slender ascending stems from a cespitose

[1] Samojed. cisural, l.c., p. 42.
[2] Synoptical Flora of North America. The Gamopetalae. Second Edit. New York, 1886, p. 371.

caudex; leaves silvery-canescent with firm very close-pressed pubescenc radical twice ternately or quinately divided or parted into oblong-linea or narrower lobes (of only 2 or 3 lines in length); cauline sparse, mostly trifi heads comparatively small (2 lines high), several or rather numerous in a stri and simple racemiform inflorescence, fuscous; corolla pilose or sometim glaborus.—*A. arctica* and *A. caespitosa*, Bess in Hook. Fl. I, 323, 324. Arct coast to Bear Lake."

A. comata Rydb.

In specimens from "Sandspit at Martin point," the numerous, dens rosettes of leaves are developed at the apex of short, very much branched, sub terranean stems with an abundance of thin, profusely branched secondar roots. In specimens from "Gravel-tundra at Collinson point" there are lon subterranean stolons, quite thick, but with only a few roots, which are quit slender; in such specimens the cushion-structure is less pronounced.

Petasites frigida (L.) Fr.

This is one of the species which by several authors have been referred t *Nardosmia* Cass. on account of the corollas of the pistillate flowers being ligulate By Reichenbach *Nardosmia* has been reduced to a mere section of *Petasites* and so it is accepted also by Bentham and Hooker. Among the species of th section *Nardosmia*, *N. glacialis* Ledeb. and *N. Gmelini* DC. have the basa leaves developed almost contemporarily with the flowers, while in the othe species as well as in *Petasites* s.s. the inflorescence appears earlier than th leaves.

From a morphological viewpoint the genus *Petasites* offers several points o interest, for instance with regard to the structure of the rhizome; in this respec several species have been discussed by Hjalmar Nilsson,[1] viz.: *P. alba* (L.) Gaertn *P. spuria* (Retz.) Reich., and *P. officinalis* Moench.

In these the rhizomes bear series of membranaceous, sheathing leaves destitute of blades, and some with blades and long petioles. In *P. frigida* th following structures have been observed. In a fruiting specimen from Hersche island, collected in August, the horizontally creeping rhizome bears a tall (2 cm.) flower-bearing stem, and at the base of this the rhizome continues as a horizontally creeping stolon, consisting of six internodes. The first three leave are scale-like, but after these follow two long-petioled, green leaves, situated very close together, while the leaves of the apical portion of the rhizome are merely scale-like. A fragment of a stolon from the same locality (Fig. 8: 2) illustrate this structure. In another specimen (Fig. 1) from the south coast of Coronation gulf, collected in July, the rhizome bears a tall, flower-bearing stem at the base of which two young, green leaves are situated. The apical portion of the rhizome bears four scale-like leaves, of which the foremost partly surrounds two, very young, green leaves. In other words, the rhizome is undoubtedly a monopodium with the flower-bearing stem axillary, as shown in figure 1. Moreover, it would appear as if the green leaves (Fig. 2) represent a very short vegetative branch developed in the axil of a scale-like leaf. Concerning the root-system, secondary long and slender roots proceed from the internodes; they are especially abundant close to the floral shoot.

The fact that *P. frigida* very seldom develops flowers in the arctic region and that it must depend, to a very considerable extent, on the vegetative reproduction, seems to indicate that the species is not well adapted to the arctic

[1] Dikotyla jordstammar. (Acta Un. Lund. XIX, 1882-83, p. 179.)

climate. Kjellman [1] has expressed the view that the plant like several others reached the arctic countries at a time, when the climate was more suitable to its existence. Nathorst has reached the same conclusion relative to its occurrence in Spitzbergen.

FIGURE 8.

1. *Petasites frigida* (L.) Fr., showing the rhizome, the leafy shoots, and the base of a flower bearing stem; natural size; specimen from Tree river. 2. Same species, showing the matured foliage; two-thirds of the natural size; specimen from Herschel island. 3, 4 and 5. Basal leaves of *Senecio resedifolius* Less.; natural size; specimens from Herschel island.

Arnica alpina (L.) Olin.

Several very tall specimens, measuring from 25 to 30 cm. in height, and bearing three heads were collected at Bernard harbour and on the south coast of Coronation gulf. There is a horizontally creeping rhizome of considerable length, densely covered with remnants of leaves, and with many slender, unbranched, secondary roots proceeding from the lower face of the internodes. At the apex of the rhizome a few pairs of opposite, green leaves are situated surrounding the base of the flower-bearing stem. Characteristic of *Arnica* is that the rhizome bears only green leaves, none scale-like.

[1] Ur Polarväxternas lif. l.c. p. 504

Saussurea alpina (L.) DC.

Has a horizontal, woody rhizome with scale-like leaves, but the ro system is very scantily represented. A dense rosette of leaves terminates t rhizome and surrounds the floral shoot.

Crepis nana Richards.

This interesting little plant forms dense cushions from only 2 to almost cm. in diameter. The primary root persists as a relatively thin, but de persisting root, branching only near the very slender apex. In continuati with the root an erect, subterranean stem arises, bearing numerous, lo petioled, green leaves and numerous, very short flowering stems which ha from two to four heads. The subterranean stem is quite thick, and shows ve plainly scars from withered leaves, crowded on account of the internodes bei extremely short.

CHAPTER II. GEOGRAPHICAL DISTRIBUTION.

By examining the geographical table (Table 1, pp. 68-75), in which I have enumerated most of the species which were collected on the arctic shore of this continent, we notice that this flora is actually a composition of two, which are very distinct, viz.: a northern and a southern. Of these the northern will, by a close analysis, soon prove to contain a large contingent from districts very remote and, although mainly northern, by no means to be restricted to these regions. But we call the flora "northern" because the most conspicuous part of its components represents the circumpolar flora. With regard to the southern element, this we readily recognize as being principally derived from our own flora, the components being either identical with American types, or at least exhibiting a striking analogy with our native species.

Such dual composition recurs in other arctic countries, marked to a greater or lesser extent, very characteristic in Greenland, less so in Finmark and Lapland, Spitzbergen, etc., but quite distinct on the Siberian coast, judging from the interesting and highly instructive sketches contributed by von Baer and Kjellman. For even if the arctic Siberian flora is not so very distinct from the circumpolar or the truly arctic flora, there are certain types which may readily be recognized as being of southern origin.

Of great interest is the fact that even on the "Barren Grounds" are species which also are at home in more hospitable surroundings, the Alps of Switzerland, the Pyrenees, and the Himalayas. And the enormous distribution, exhibited by some of these plants, may solve the problem as to the migration of the ancestral, circumpolar species during the glacial epoch. But at the same time such widely scattered distribution farther south may lead to the acceptance of the theory pronounced by Schouw who, with so very few words, but substantiated by brilliant observations, explained the problem as "Eadem momenta cosmica easdem plantas diversis in locis produxisse."[1] In other words, while emigration and return of the arctic plants, so admirably discussed by Nathorst,[2] cannot be contested, there is nevertheless some difficulty in realizing the fact that some of these northern types have found their way to the mountains at such enormous distance from the arctic region.

Nevertheless, some of these difficulties have been removed by the many important points which Nathorst has brought up, especially with reference to the supposed composition and distribution of the former arctic flora, its migration to the south during the glacial epoch and, finally, its retreat when the ice receded. It is, for instance, an indisputable fact that the Altai mountains harbour a considerable element of arctic flora besides which the vegetation of these mountains shows an unusual large number of species common to other mountains, though far remote. And the natural cause of this wide distribution of the Altai flora is by Nathorst explained as depending on the favourable conditions in these mountains during the glacial epoch. When the temperature decreased, and the alpine element of the Altai flora was forced to descend to the lowlands, the flora was then able to distribute itself over the lowlands of all northern Asia. For, contrary to Europe, there was no inland ice to prevent its distribution; the plants were enabled to spread as far north as the climatologic conditions permitted. Moreover, the relatively northern situation of these mountains was an important factor with regard to the migration of the plants to the arctic region.

[1] Schouw, J. F. Dissertatio de sedibus plantarum originariis. Havniae, 1814.

[2] Polarforskningens Bidrag till Forntidens Växtgeografi. (A. E. Nordenskiöld Studier och Forskningar. Stockholm, 1883. p. 231.)

No doubt the Altai mountains constitute a most important centre of tribution, and many species were developed there which succeeded in reac the northeastern corner of Asia, and from there extending to arctic Am and Greenland. A similar important centre was undoubtedly located in European Alps, known to be so very rich in alpine species, many being end to these mountains. Furthermore, the Rocky mountains bear evidence of ha been the actual centre of an old, alpine vegetation, of which several species entered the arctic region and now constitute a large element, a truly Amer one, of the polar flora.

These data are consequently of great importance to the solving of problem regarding the probable location of the centres of development distribution of our arctic plants.

However, such singular distribution of plants is more readily obser when we deal with the alpine vegetation, comparing this with the arctic. instance, in Colorado the alpine vegetation illustrates the fact at once, that composed of six elements: circumpolar types; arctic, but not circumpo northern, but not arctic types; northern types, endemic to North Amer and finally there are some southern types common to both Worlds, or ende to North America. This heterogeneous composition naturally induces u attempt some sort of tabulation of the complete geographical distributio the arctic species. But it is by no means an easy task to mark down a num of species credited to the various districts in the north and south. And difficulty presents itself from the indisputable fact that many species repo from the arctic have also been recorded from the south, but under other nam I think especially of such species as have originated in the arctic region, were forced to migrate to the south during the glacial epoch; some of these w left on the southern mountain summits, while the others returned to t northern homes when the ice receded. Such species as were left on these mo tains thus represent remnants of a glacial flora, and naturally the change in climatologic conditions has, sometimes, resulted in their appearance un disguised forms which not infrequently pass for different species.

Nevertheless, if such tabulation be not absolutely correct, it will alw give us some idea of the distribution, in a general way, of a number of spe which are still recognized as identical, northern as well as southern types.

Having thus reached to obtain a view of the geographical distribution, alpine element proves a surprisingly large representation in the north, and esp ally in the arctic region. And besides that, this same vegetation, at least a num of the alpine species, show also a more or less extensive distribution throu out the southern mountainous regions of both Worlds. Among these spec we meet thus with some that extend to the arctic region, and others of wh the distribution may extend far to the north, but without reaching the arc countries. Of these the latter frequently show a vast distribution through the northern hemisphere and, moreover, a distribution which may pr exceedingly scattered. The occurrence may be so scattered, indeed, that are at a loss to appreciate how the species ever reached such stations, so rem from each other.

And as will be demonstrated in the subsequent pages, the species, whic have in view, are not only such as occur on the summits of the higher mountai very remote from each other, but also such as are more or less lowland plan With respect to the origin of some of these, I have suggested the probability more than a single centre, which by no means will be in opposition to the ind putable theory relative to the migration of the plants during and after t glacial period.

Some few examples may be cited to illustrate the probability of a sin centre, viz.: *Carex festiva*, and of evidently several: *C. atrata* and *C. alpi* Having studied several species of the genus *Carex* from this particular point view, we might consider for instance *C. festiva*. This species is arctic, but neith

circumpolar nor strictly alpine; it is relatively rare in the polar regions, but it has been recorded from northeastern America, Greenland, Iceland, and Finmark, where it occurs only as what may be termed the "typical" plant. But much farther south and especially in the subalpine zone of the Rocky mountains is a herd of this same species, accompanied by several aberrant forms, besides by species that are apparently distinct, but among its closest allies: *C. athrostachya*, *C. pratensis*, *C. petasata*, etc. Judging from our present knowledge of the distribution of *C. festiva*, its geographical centre seems to have been in the south, in the Rocky mountains, where it is, thus, typically developed, and associated with characteristic varieties, and with allied species. A more complicated case may be illustrated by *Carex atrata* and *C. alpina*. The former is only known as arctic in a few stations of Greenland and the European continent, while the latter has been collected in arctic Russia, Finmark, Greenland, and North America, but is more frequent farther south. In the Rocky mountains of Colorado these species are associated with several allied types, e.g. *C. melanocephala*, *C. bella*, and *C. chalciolepis:* a close ally of *C. atrata*, *C. ovata*, abounds in the northeastern part of this continent, thus illustrating the occurrence of allied types associated with each other. This might indicate the location of the geographical centre as being in the Rocky mountains, so far as concerns the American representatives of *C. atrata* and *C. alpina*. In Europe *C. atrata* is, to some extent, accompanied by two plants, *C. nigra* and *C. aterrima*, both of which may be looked upon as immediate allies of this species. And if we extend our comparison of these species with those that occur in the Himalayas, we find there not only *C. atrata* and *C. alpina*, but also some deviating forms, and some allied species, among which *C. Lehmannii*, *C. obscura*, *C. Duthiei*, and *C. nivalis*. If thus the association with allies in connection with frequent occurrence and tendency to vary may throw some light upon the question as to their centre of distribution, I certainly consider it natural to attribute to these species three distinct centres, one in the Rocky mountains, another in the European Alps, and a third one in the Himalayas.

Similar results may be obtained by comparing the distribution of other plants, when represented in both Worlds. For instance, *Anemone narcissiflora*, *Lloydia*, *Elyna*, *Pyrola*, *Saxifraga*, and several others from the arctic shore are very instructive from this particular point of view.

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Geographical Table I.

	Polar Regions																				
	Islands of the arctic American archipelago	Greenland	Spitzbergen	Arctic Scandinavia	Arctic Russia	Nova Zembla	Arctic Siberia	Iceland	Alps and Pyrenees	Caucasus	Asiatic coast of Bering strait	Himalaya	Altai and Baikal mts.	Rocky mountains	American coast of Bering strait	Kamchatkan mountains					
Cystopteris fragilis (L.) Bernh.	•	•	•	•	•	•		•	•	•	•	•	•	•	•						
Dryopteris fragrans (L.) Schott	•	•					•														
Equisetum arvense L.	•	•	•	•	•	•	•	•	•	•	•		•	•	•						
E. variegatum Schleich.	•	•	•			•		•	•					•							
Lycopodium Selago L.	•	•	•	•	•	•	•	•	•	•	•		•								
Hierochloë pauciflora R. Br.	•						•														
H. alpina (Lilj.) R. et S.	•	•	•	•	•	•	•				•		•		•						
Alopecurus alpinus Sm.	•	•	•		•	•	•														
Arctagrostis latifolia (R. Br.) Griseb.	•	•	•	•	•	•	•				•		•		•						
Calamagrostis purpurascens R. Br.	•	•												•	•						
Trisetum spicatum (L.) Richt.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•						
Catabrosa algida (Soland.) Fr.	•	•	•	•	•	•	•	•	•		•				•						
Poa glauca M. Vahl	•	•	•	•	•				•		•				•						
P. abbreviata R. Br.	•	•	•																		
P. arctica R. Br.	•	•	•	•	•	•	•				•	•	•	•	•						
Arctophila effusa Lge.	?	•	•		•	•	•				•										
Dupontia Fischeri R. Br.	•		•		•	•	•														
Glyceria vilfoidea (Anders.) Fr.	•	•	•				•														
G. tenella Lge.	•					•															
G. vaginata Lge.		•				•	•														
Festuca ovina L. var. *brevifolia*	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•						
F. rubra L. var. *arenaria*	•	•	•		•	•	•				•										
F. altaica Trin.											•	•	•								
Hordeum jubatum L.														•							
Elymus mollis Trin.	•						•				•										
Eriophorum Scheuchzeri Hoppe	•	•	•	•	•	•	•	•	•		•	•			•						
E. vaginatum L.	•	•?		•	•	•	•		•	•	•		•								
E. angustifolium Roth.	•	•	•	•	•	•	•	•	•		•		•	•	•						
Elyna Bellardii (All.) Koch	•	•		•	•		•	•	•	•			•		•						
Carex incurva Lightf.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•						
C. rigida Good.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•						

Geographical Table I.

| | Polar Regions | | |

Geographical Table I.

| | Polar Regions | | |

Geographical Table I

Polar Regions

	Islands of the Arctic American Archipelago	Greenland	Spitzbergen	Arctic Scandinavia	Arctic Russia	Nova Zembla	Arctic Siberia	Iceland	Alps and Pyrenees	Caucasus	Asiatic coast of Bering strait	Himalaya	Altai and Baikal mts.	Rocky mountains	American coast of Bering strait	Appalachian mountains
R. pygmaeus Wahlenb.	•	•	•				•	•			•				•	
R. lapponicus L.	•	•				•	•								•	
R. gelidus Kar. et Kir.[1]																
R. sulphureus Soland.	•	•	•	•		•	•						•			
R. nivalis L.	•	•				•	•	•			•	•			•	
R. affinis R. Br.	•	•	•			•	•				•	•			•	
R. Sabinii R. Br.	•	•														
R. occidentalis Nutt. v. *robustus* Gr.																
Papaver nudicaule L.	•	•	•	•	•	•	•	•			•	•	•	•	•	
Lesquerella arctica (Rich.) Wats.		•													•	
Thlaspi alpestre L.v. *purpurascens* (Rydb.) Ostf.														•		
Cochlearia groenlandica L.		•	•	•	•	•										
Draba alpina L.	•	•	•	•	•	•	•	•			•	•	•			
D. nivalis Liljebl.	•	•	•	•	•	•	•	•	•		•					
D. fladnizensis Wulf.	•	•	•	•	•	•	•	•	•		•	•	•		•	
D. corymbosa R. Br.		•	•													
D. hirta L.	•	•	•	•	•	•	•	•			•		•		•	
Braya purpurascens (R. Br.) Bunge	•	•	•		•	•										
B. alpina Sternb. et Hoppe		•		•		•	•					•			•	
Eutrema Edwardsii R. Br.	•	•	•		•	•	•				•		•		•	
Hesperis Pallasii (Pursh) T. & G.	•	•														
Cardamine digitata Richards.	•										•				•	
C. pratensis L.	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•
Parrya macrocarpa R. Br.			•		•	•	•				•	•	•		•	
P. arctica R. Br.	•															
Erysimum inconspicuum (Wats.) McMill.														•		
Sisymbrium sophioides Fisch.																
Chrysosplenium tetrandrum Th. Fr.	•		•	•	•	•	•				•			•	•	

[1] Described from specimens collected in the Ala-Tau Mountains in Central Asia.

| Geographical Table I. | Polar Regions | | |

Geographical Table 1.

| | Polar Regions | | |

Geographical Table I.	Polar Regions																	
	Islands of the arctic American archipelago	Greenland	Spitsbergen	Arctic Scandinavia	Arctic Russia	Nova Zembla	Arctic Siberia	Iceland	Alps and Pyrenees	Caucasus	Asiatic coast of Bering strait	Himalaya	Altai and Baikal mts.	Rocky mountains	American coast of Bering strait	Appalachian mountains
Primula borealis Duby	•						•				•				•	
P. stricta Hornem.		•		•	•	•									•	
P. sibirica Jacq.				•			•						•			
Douglasia arctica Hook																
Androsace Chamaejasme Host.	•				•	•	•		•	•	•		•	•	•	
A. septentrionalis L.	•			•	•	•			•	•	•		•	•	•	
Statice Armeria L. f. *sibirica* (Turcz.) Simm.	•	•		•		•	•	•			•		•		•	
Gentiana arctophila Griseb.																
G. propinqua Richards							•								•	
Pleurogyne rotata Griseb.		•			•			•			•		•		•	
P. carinthiaca Griseb.									•	•		•	•			
Phlox Richardsonii Hook.	•															
Polemonium caeruleum L. v *villosum* (Rud.) Brand.					•	•	•				•		•			
P. boreale Adams.	•	•	•	•	•	•	•				•		•		•	
Myosotis silvatica Hoffm.				•	•	•	•	•	•	•	•	•	•	•	•	
Mertensia Drummondii Don.																
M. paniculata Don.											•			•	•	
M. maritima (L.) S. F. Gray.	•	•	•	•	•			•			•				•	
Castilleja pallida (L.) Kunth.	•	•			•		•						•		•	
Pedicularis lapponica L.	•	•		•	•		•			•			•			
P. verticillata L.					•		•		•		•	•	•			
P. hirsuta L.	•	•	•	•	•	•	•								•	
P. sudetica Willd.	•	•			•	•	•				•				•	
P. arctica R. Br.	•						•				•				•	
P. lanata Cham. et Schl.	•	•	•			•	•				•				•	
P. capitata Adams	•						•				•		•		•	
Pinguicula vulgaris L.		•		•	•		•	•	•						•	•
Lagotis glauca Gaertn. v. *Stelleri* Cham. et. Schl					•	•	•				•				•	
Plantago lanceolata L.								•	•	•		•		•		•
Valeriana capitata Pall.					•	•	•			•	•		•		•	

Table I.

| Geographical | Polar Regions | | |

With respect to the vegetation covering the arctic coast, explored by the expedition, the arctic element is by far the most predominant. It is indeed readily to be seen that of the 230 species collected not less than 84 are circumpolar; these are as follows:

Cystopteris fragilis
Equisetum arvense
Lycopodium Selago
Hierochloë alpina
Alopecurus alpinus
Arctagrostis latifolia
Trisetum spicatum
Poa arctica
Arctophila effusa
Dupontia Fischeri
Festuca ovina, mostly the var. *brevifolia*
Festuca rubra var. *arenaria*
Eriophorum Scheuchzeri
" *vaginatum*
" *angustifolium*
Carex incurva
" *rigida*
" *subspathacea*
" *rariflora*
" *misandra*
" *pulla*
Juncus biglumis
Luzula hyperborea
" *spicata*
Tofieldia palustris
Salix glauca
" *reticulata*
" *polaris*
Polygonum viviparum
Oxyria digyna
Lychnis apetala
" *affinis*
Stellaria humifusa
Cerastium alpinum
Halianthus peploides
Alsine verna var. *rubella*
Caltha palustris
Ranunculus hyperboreus
" *pygmaeus*
" *lapponicus*
" *nivalis*
Papaver nudicaule
Draba alpina
" *nivalis*
" *fladnizensis*
" *hirta*
Eutrema Edwardsii
Cardamine pratensis
Chrysosplenium tetrandrum
Saxifraga rivularis
" *cernua*
" *Hirculus*
" *nivalis*
" *hieraciifolia*
" *decipiens*
" *oppositifolia*
Sedum Rhodiola
Dryas octopetala
Potentilla palustris
" *nivea*
Rubus Chamaemorus
Astragalus alpinus
Phaca frigida
Empetrum nigrum
Epilobium latifolium
" *angustifolium*
Hippuris vulgaris
Ledum palustre
Loiseleuria procumbens
Cassiope tetragona
Arctostaphylos alpina
Vaccinium uliginosum v. *microphyllum*
Vaccinium Vitis-Idaea
Polemonium boreale
Myosotis silvatica
Pedicularis lapponica
" *hirsuta*
" *sudetica*
Pinguicula vulgaris
Erigeron uniflorus
" *alpinus*
Antennaria alpina
Artemisia vulgaris v. *Tilesii*
Petasites frigida

The Gramineae and Cyperaceae are the best represented, each by 9 species; then follow the Caryophyllaceae and Saxifragaceae each with 7, the Cruciferae with 6, the Compositae with only 5, the Rosaceae with 4, etc.

By comparing the species found in the region explored by the expedition with those reported from Spitzbergen by Nathorst, Andersson and Hesselman (l.c.), it will be seen that 84 species are common to both, and of these 59 are among the circumpolar ones. On the other hand the flora of Spitzbergen contains 40 species which are absent from the region visited by the expedition; these species are as follows:

****Equisetum scirpoides*
" *tenellum*
**Poa pratensis*
* " *alpina*
" *stricta*
**Glyceria angustata*
* " *Vahliana*
** " *Kjellmanni*
Catabrosa concinna
* " *algida*
**Aira caespitosa*
** " *alpina*
***Calamagrostis stricta*
**Carex ursina*
* " *lagopina*
* " *glareosa*
** " *parallela*
* " *nardina*
Salix polaris
**Betula nana*
* *Koenigia islandica*
**Arenaria ciliata*
**Alsine Rossii*
* " *biflora*
***Sagina nivalis*
***Ranunculus glacialis*
***Draba arctica*
* " *oblongata*
" *altaica*
**Cochlearia fenestrata*
**Arabis alpina*
**Cardamine bellidifolia*
Potentilla fragiformis
** " *maculata*
" *multifida*
**Saxifraga stellaris* forma *comosa*
**Cassiope hypnoides*
***Gentiana tenella*
***Taraxacum officinale*
* " *phymatocarpum*

However, of these 40 species, 22 are recorded by Simmons from the arctic American archipelago (l.c.), and I have marked these with an asterisk in the list given above. In other words, of the 124 species known from Spitzbergen, 106 occur also on the arctic coasts of this continent. And if we extend the comparison to the coasts of Greenland, 11 species may be added (marked with two asterisks) which the northern region from the east coast of Greenland to Point Barrow has in common with Spitzbergen. The species which thus inhabit Spitzbergen, but which are absent from this part of arctic America, including Greenland, are as follows:

Equisetum tenellum
Poa stricta
Catabrosa concinna
Salix polaris
Draba altaica
Potentilla fragiformis
" *multifida*

Equisetum tenellum (Liljebl.) Krok was first described by Liljeblad,[1] who referred it to *E. hiemale* as a variety, but with the remark that it might represent a distinct species; it was found in Torne Lapmark, and the mountains of Jamtland. Blytt (Norges Flora l.c. p. 6) refers it to *E. scirpoides* Michx.; the variety *tenellum* of *E. palustre* described by Elias Fries[2] is, of course, a different plant.

Poa stricta Lindeb. is known also from some mountains in Sweden and Norway, but with the exception of its occurrence in Nova Zembla, no stations in Russia or in Siberia are recorded by Trautvetter.[3]

Catabrosa concinna Th. Fr. has also been found in Nova Zembla, Waigatsch, and some few stations in western arctic Siberia: Jalmal and Dickson's harbour.

Salix polaris Wahlenb., on the other hand, is widely distributed from Dovre, Finmark, Lapmark, through arctic Russia and Siberia. From this continent, but outside the region visited by the expedition, *Salix polaris* has been reported from Port Clarence and from St. Lawrence island by Kjellman.[4]

Draba altaica is a native of the Altai mountains, but it has furthermore been reported from arctic Siberia (Dickson's harbour), and from Nova Zembla.

Potentilla fragiformis Willd. has been collected on Nova Zembla, in arctic

[1] Utkast til en Svensk Flora. 2nd. Edit. Upsala, 1793, p. 384.
[2] Flora Scanica. Upsala, 1835, p. 155
Incrementa Fl. Phaenog. Rossicae l.c.,.
[4] Fanerogamer från Vest-Eskimåernas land (Vega Exped. Vetensk. Iakttl. Vol. 2. Stockholm, 1883.) Fanerogamfloran på St. Lawrence ön. ibidem, Vol. 2. Stockholm, 1883

Russia, according to Trautvetter (l.c.), beside at some few stations in arctic Siberia.

Potentilla multifida L. is very rare in the Alps of Switzerland, but has also been reported from Caucasus, southern Russia, and Siberia.

With regard to Greenland the table shows that 129 species of the Greenland flora occur also in the region explored by the expedition; of these species 76 are among the circumpolar ones. Common to Greenland and the islands of the arctic American archipelago, but absent from our region are:

Woodsia ilvensis (L.) R. Br.
W. glabella R. Br.
Lycopodium annotinum L.
Agrostis canina L.
A. borealis Hartm.
Calamagrostis lapponica (Wahlenb.) Hartm.
Aira caespitosa L.
A. atropurpurea Wahlenb.
Catabrosa aquatica (L.) Beauv.
Pleuropogon Sabinii R. Br.
Poa pratensis L.
P. alpina L.
P. laxa Hnke.?
Glyceria Vahliana Liebm.
Agropyrum violaceum (Hornem.) Lge.
Elymus arenarius L.
Kobresia caricina Willd.
Carex nardina Fr.
C. ursina Dew.
C. gynocrates Wormskj.
C. lagopina Wahlenb.
C. glareosa Wahlenb.
C. alpina Sw.
C. pedata Wahlenb.
C. ustulata Wahlenb.
C. capillaris L.
Juncus castaneus Sm.
Luzula parviflora (Ehrh.) Desv.
Salix herbacea L.
Betula nana L.
Koenigia islandica L.
Sagina nivalis Fr.
Alsine biflora (L.) Wahlenb.
Arenaria ciliata L.
Ranunculus glacialis L. (?)
Cardamine bellidifolia L.
Arabis arenicola (Richards.) Gelert.
Arabis alpina L.
Saxifraga Aizoon Jacq.
S. stellaris L.
Potentilla maculata Pourr.
P. tridentata Soland.
Pyrola minor L.
Phyllodoce caerulea (L.) Gren. et Godr.
Cassiope hypnoides (L.) Don.
Arctostaphylos Uva-ursi (L.) Spreng.
Diapensia lapponica L.
Euphrasia latifolia Pursh.
Pedicularis flammea L.
Campanula rotundifolia L.
Gnaphalium norvegicum Gunn.
Artemisia borealis Pall.
Taraxacum phymatocarpum Vahl.

in all, 53 species, 23 of which are Gramineae and Cyperaceae.

Among these species, which the arctic American archipelago has in common with Greenland, the following occur furthermore in the Hudson bay region:

Agrostis canina
Aira cæspitosa
Catabrosa algida
Poa alpina
Agropyrum violaceum
Elymus arenarius
Carex gynocrates
C. glareosa
C. alpina
C. ustulata
Juncus castaneus
Luzula parviflora
Salix herbacea
Betula nana
Koenigia islandica
Sagina nivalis
Cardamine bellidifolia
Arabis alpina
Saxifraga Aizoon
S. stellaris
Potentilla maculata
P. tridentata
Pyrola minor
Phyllodoce caerulea
Cassiope hypnoides
Arctostaphylos Uva-ursi
Diapensia lapponica
Pedicularis flammea
Campanula rotundifolia
Artemisia borealis

in all, 30 species.

Of these species the following are circumpolar:

Aira caespitosa	*Cardamine bellidifolia*
Calabrosa algida	*Arabis alpina*
Carex glareosa	*Saxifraga stellaris*
Luzula parviflora	*Campanula rotundifolia*
Salix herbacea	*Artemisia borealis*

However, the Hudson bay region, between 55° and 65° N. L., is quite rich in arctic species, and of the about 450 species which are known from there, about 90 are circumpolar, including those enumerated above.

Most of these circumpolar plants evidently belonged to a flora, which in tertiary times inhabited the polar regions, but was forced towards the south during the glacial epoch. Many of these sought refuge in the higher mountains, but returned to their northern homes when the ice receded. And on their retreat to the polar regions they were accompanied by a number of southern, mainly alpine, species; thus the present arctic flora is also represented by a southern element. However, the probability is that not a few of the circumpolar plants remained on the southern mountains, some to persist, others to succumb. This may be demonstrated by the indisputable fact that the alpine flora shows a commingling of types similar to the present arctic flora. These foreign arctic types are remarkably distinct, according to longitude, an American element being represented in the arctic American flora, a European in the arctic European, and a Siberian in the arctic Asiatic. For instance, the occurrence of the American *Astragalus aboriginorum* in arctic America, the American *Erigeron compositus* in arctic America and Greenland, etc. But it is merely conjectural to determine the actual roads, followed by these plants from the polar regions to the south, as well as on their retreat. And the difficulty culminates especially when we bear in mind the extraordinarily scattered distribution of some of these polar plants in southern regions, the higher mountains for instance. It is still more difficult to appreciate the actual means by which the migration became effected. Great importance has been attributed to the belief that migratory birds carry with them seeds of plants, but recently we have learned that such birds migrate on an empty stomach, and are almost always clean when they commence their long journey. This statement we owe to Knud Andersen,[1] who made the startling observation in Denmark, that during a period of 4-5 years the intestines of all the birds killed near the lighthouses were found to be empty, beside the fact that no seeds were found adhering to any parts of these birds. However, Professor Henry W. Henshaw[2] has, more recently, expressed an opinion which is entirely different, making the following statement:

"The sources of the vegetation and the means by which the seeds of plants and shrubs were originally transported to these distant ocean-girt islands, thousands of miles from the nearest mainland, are a most inviting field of speculation. The winds are capable of conveying minute seeds to great distances, and favourable ocean currents also materially aid as plant distributors. Birds, however, are doubtless the most important of nature's seed carriers. Viscid and hooked seeds attach to their plumage, or seeds may be carried in smears of earth or mud on feathers, bill, or feet. Such seeds may be transported indefinite distances and, once in a thousand years or so, dropped on soil favourable to growth. The members of the most recent expedition to the island, the Nutting party in 1911, were especially requested to examine carefully all their specimens of Laysan birds for the presence of seeds, and actually found attached to the foot of a Laysan albatross a seed of a species of the bean-caper family, which is generally distributed in the South Sea islands. So far as known the plant does not grow on Laysan, and had this seed chanced to fall in a favourable spot the

[1] Compare C. H. Ostenfeld in Botany of the Faeroes. Part I, p. 117. Copenhagen, 1901.
[2] Henshaw, H. W. Our Mid-Pacific Bird Reservation. Yearbook of the Dept. of Agric. 1911. Washington, D.C.

flora of the island might have been enriched by another species. A still more striking instance of a bird acting as a carrier of seeds was observed several years ago by Mr. Bryan on Marcus Island, where he found no fewer than 40 seeds of a tree of the madder family adhering to the feathers of a shearwater. These and other similar facts show how the flora of oceanic islands may be transported by birds from island to island or from continents to distant shores."

Furthermore, that resident birds, as for instance the partridge, may well transport many seeds from one place to another, has been pointed out by Darwin.[1]

With regard to other factors of dispersion, water for instance, we know, so far, too little about the possibility of seeds retaining their vitality during prolonged immersion in salt water. The transport by means of ice may take place, as pointed out by Simmons, when the question merely deals with narrow channels or fjords, but, nevertheless, more indirectly so, since the wind becomes a more or less necessary, additional factor for carrying the seeds to the shore.

However, even if we have reached no decisive conclusion as to the means by which the migration was effected, nor by what roads it took place, we do know that the plants exist there, that arctic and alpine species do occur in the polar regions, and quite a number of these furthermore in the mountains farther south. It seems even plausible to suppose that the mountains harbour a larger number of arctic remnants than has really been accounted for, because the arctic species in the mountains as well as the alpine species in the arctic region may have submitted to a more or less pronounced modification in structure due to the change of conditions. Such modification, in external structure especially, may, as stated above, have resulted in the respective species appearing in disguise, and being mistaken for separate species. In this way botanical manuals, comprising floras of mountainous regions, are sometimes crowded with supposed new species which actually are simply modified forms or varieties produced by change of environment, especially climate and soil. Consequently, when dealing with plants scattered over large areas, we must consider whether they represent analogous types or mere forms. *Artemisia*, *Antennaria*, *Draba*, and several other genera have recently furnished an almost untold number of supposed new species, regardless of the natural modification to be sought in "geographical distribution."

Returning to the circumpolar species, these having been so admirably described and their distribution discussed by some of the ablest botanists, the danger of errors in their determination is but slight, even if more recently some authors have ventured to make changes—as a rule wholly unwarranted.

Having enumerated the circumpolar species, collected by the expedition we shall now offer a few data regarding their occurrence in other regions; moreover, some points will be discussed relative to the southern, the alpine element which has also become distributed in the polar regions.

In accordance with the enumeration of the circumpolar species, given in the preceding pages, and the accompanying table, it will be seen that those exhibiting the widest geographical distribution farther south are as follows:

Cystopteris fragilis, *Equisetum arvense*, *Lycopodium Selago*, *Trisetum spicatum*, *Poa arctica*, *Festuca ovina*, especially the variety *brevifolia*, *F. rubra* var. *arenaria*, *Eriophorum Scheuchzeri*, *E. vaginatum*, *E. angustifolium*, *Carex incurva*, the distribution of which on this continent extends as far south as the Strait of Magellan; *C. rigida*, which, however, in the Caucasus occurs only as the variety *dacica*, a plant, which Boissier (Fl. orient., Genève, 1867-84) has enumerated as *C. rigida*, but by Richter (Pl. Europ., Leipzig, 1890-1903) has been referred to *C. caespitosa* v. *dacica*. Furthermore *Carex misandra*, *C. pulla*, *Juncus biglumis*, *Salix reticulata*, *Polygonum viviparum*, *Oxyria digyna*, *Lychnis apetala*, *Cerastium*

[1] Darwin, C. On the Origin of Species. Fourth Ed. London, 1866, p. 432.
See also: Hesselman, H. Några iakttagelser öfver växternas spridning. Botan. Notiser, 1897, p. 9

alpinum, Papaver nudicaule, Draba fladnizensis, Cardamine pratensis, Saxifraga cernua, S. Hirculus, S. nivalis, S. hieraciifolia, S. decipiens, S. oppositifolia, Sedum Rhodiola, Dryas, Potentilla nivea, P. palustris, Empetrum, Epilobium, Erigeron uniflorus, and *E. alpinus.*

From this small enumeration it will be seen that most of these species may have their spores, seeds, or fruit readily dispersed by means of the wind, especially the Pteridophyta, the Gramineae, Cyperaceae, notably *Eriophorum*, the *Salix*, *Oxyria*, *Dryas*, etc. But *Saxifraga cernua*, *Polygonum viviparum*, and perhaps also *Cardamine pratensis* form an exception, since the production of bulblets has taken the place of fertile flowers; with regard to *Empetrum*, the seeds of the fleshy fruits may be dispersed only by means of animals.

However, many of the other species are just as well adapted to be dispersed, especially by the wind; thus their more or less scant distribution farther south may be due to their local extermination, or perhaps because they may represent young species of northern origin. I think especially of the willows, which undoubtedly have an important centre in the northern regions.

With regard to the truly arctic element, there are several species which, although not being circumpolar, may be looked upon as genuine arctic types, and some of these have not, so far, become distributed farther south. Among these may be mentioned *Hierochloë pauciflora*, *Poa abbreviata*, *Glyceria*, *Carex stans*, *C. subspathacea*, *C. reducta*, *C. compacta*, *Luzula nivalis*, *Salix rotundifolia*, and several other species of *Salix*, *Rumex*, *Lychnis Taylorae*, *Alsine macrocarpa*, *Merckia*, *Anemone Richardsonii*, *Ranunculus Pallasii*, *R. Sabinii*, *Lesquerella*, *Cochlearia*, *Draba corymbosa*, *Braya purpurascens*, *Hesperis*, *Cardamine digitata*, *Parrya arctica*, *Saxifraga radiata*, *Dryas integrifolia*, *Sieversia*, *Potentilla pulchella* and several other *Potentilla* species, *Rosa acicularis*, *Lupinus*, *Hedysarum*, *Selinum*, *Pyrola*, *Cassiope*, *Dodecatheon*, *Primula borealis*, *P. stricta*, *Gentiana*, *Phlox*, *Mertensia Drummondii*, *Pedicularis hirsuta*, *P. arctica*, *P. capitata*, *Lagotis*, *Aster*, *Achillea*, *Chrysanthemum integrifolium*, *Artemisia vulgaris* var. *Tilesii*, *Arnica*, *Senecio resedifolius*, *Saussurea*, *Taraxacum*, and *Crepis*. About 60 species, and adding to these the 80 circumpolar ones, we have in all 140 species, collected by the expedition, which may be termed strictly arctic, so far as we know, at least in accordance with their present distribution, being absent from regions farther south. The remaining species, about 90, may be partly such as have originated in the arctic regions, but of which a certain element remained in the mountains while the others returned. And another part consists of southern species which accompanied the arctic on their retreat. These southern species cannot with certainty be defined, except that their distribution in the arctic region, being either very scant or scattered, might indicate their southern origin. As far as concerns the structure of arctic species, it has been shown in the preceding pages that no morphological structure seems absolutely characteristic of these; they share the same development of their floral and vegetative organs with their southern, allied species; they exhibit exactly the same method of vegetative reproduction as these, and are, indeed, in many cases not of such dwarfed stature as frequently described. But they resemble alpine plants, and they are, with but very few exceptions, perennial like them.

There is thus no absolute morphological character by which arctic and some species may be defined, and we must therefore consider them from other points of view, when the question arises to distinguish them, in the present case to draw the line between the northern and southern element. It may be possible to establish such a distinction by means of comparing the genera, or in some cases the species. And in this case we are allowed to include, but only as supplementary, peculiarities in their morphological structure.

In the subsequent pages I shall endeavour to show the importance of the present geographical distribution in defining the probable location of the

centre of these species, their centre of development and of distribution. For this purpose I have especially selected such species as are not circumpolar, and of which the distribution in the south is well exemplified.

In beginning with the Pteridophyta, the species collected by the expedition are too few to give us any idea of the representation of this group of plants in the arctic region. Therefore, in the accompanying table (Table 2), I have enumerated all the species known from our arctic shore, including the islands of the archipelago, and from Greenland; however, in view of the fact that several species reported from Greenland have not, so far, been found on our arctic shore, a special column has been given to the species known from that country. On the other hand, no column has been given to arctic Siberia, since, according to Ledebour (Fl. Rossica l.c.), *Dryopteris fragrans* is the only fern recorded from

TABLE 2.

Geographical distribution of arctic Pteridophyta, principally in the northern regions of both Worlds.

	Arctic coast of America, including the islands	Greenland	Spitsbergen	Arctic Scandinavia	Arctic Russia	America south of the arctic region	Alps and Pyrenees	Ural	Caucasus	Altai and Baikal mountains	Kamtchatka
Phegopteris polypodioides Fée		•		•	•	•	•	•		•	•
P. Dryopteris (L.) Fée		•		•	•	•	•	•		•	•
Cryptogramma acrostichoides R. Br.	•					•					
Asplenium viride Huds.		•		•		•	•				
Polystichum Lonchitis (L.) Roth	•	•		•	•	•	•		•	•	
Dryopteris fragrans (L.) Schott.	•	•				•		•		•	•
D. spinulosa (Müll.) Kze.		•		•	•	•	•	•	•	•	•
Blechnum spicant (L.) Roth		•		•		•	•		•		
Cystopteris fragilis (L.) Bernh.	•	•	•	•	•	•	•	•	•	•	•
Woodsia ilvensis (L.) R. Br.	•	•		•	•	•		•	•	•	
W. hyperborea R. Br.	•	•		•	•	•				•	
W. glabella R. Br.	•	•	•			•				•	
Botrychium Lunaria (L.) Sw.		•		•	•	•	•	•	•	•	
B. lanceolatum (Gmel.) Ang.		•		•		•					
Equisetum arvense L.	•	•	•	•	•	•	•	•	•		
E. silvaticum L.		•		•	•	•	•	•	•	•	•
E. palustre L.	•			•	•	•	•	•	•	•	
E. variegatum Schleich.	•	•	•	•	•	•				•	
E. scirpoides Michx.	•		•	•		•				•	•
Lycopodium Selago L.	•	•	•	•	•	•	•	•	•	•	
L. annotinum L.	•	•		•	•	•	•	•		•	•
L. alpinum L.		•		•	•		•	•		•	•
Selaginella selaginoides (L.) Lk.		•									
Isoëtes echinospora Dur.		•									

that region.: "Ad lacum Falkadja Lat. 73° 30′ prope flumen Taimyr rarissime (Middendorff et Ruprecht)." Besides this fern, *Lycopodium Selago*, *L. complanatum*, and *Equisetum arvense* are the only Pteridophyta recorded from arctic Siberia, and by adding their occurrence in Siberia to the other stations given in the table (Table 2) it will be seen that *Lycopodium Selago* and *Equisetum arvense* are circumpolar, in fact the only circumpolar Pteridophyta known so far. *Lycopodium complanatum*, on the other hand, is not circumpolar, since it is absent from arctic America.

With regard to the occurrence of the Pteridophyta in the arctic region, I wish to offer some few statements relative to Greenland. Between Lat. 62° and 72°, Frederikshaab-Upernivik on the west coast, ferns are not uncommon; they are especially well represented in crevices of rocks near mountain brooks, for instance, *Polystichum Lonchitis*, *Phegopteris polypodioides*, *P. Dryopteris*, and *Dryopteris spinulosa;* on dry rocks we meet with the species of *Woodsia*, *Dryopteris fragrans*, and *Cystopteris*. The very rare *Asplenium viride* I found growing in deep shade, in a grotto, associated with luxuriant specimens of *Dryopteris*.

The Equisetaceae, notably *E. scirpoides*, are quite common, and among the Lycopodiaceae, *L. alpinum* and *L. Selago* are very frequently met with, and sometimes quite abundant. The latitude reached by some of these species in Greenland is quite remarkable; the following quotations may be of interest

Cystopteris fragilis 76°
Woodsia hyperborea 73° 21′
Dryopteris fragrans 72° 53′ (73° 30′ in Siberia)
Woodsia ilvensis 72° 48′
Equisetum arvense 72°
Woodsia glabella 71° 67′
Lycopodium Selago and *Equisetum variegatum* 71°
Equisetum scirpoides, *E. silvaticum*, and *Lycopodium alpinum* 70°
Botrychium Lunaria 69° 20′
Phegopteris Dryopteris and *Polystichum Lonchitis* 69° 15′
Phegopteris polypodioides and *Dryopteris spinulosa* 65° 40′
Selaginella selaginoides 64° 15′

This northern distribution may be extended farther if we compare the stations, known from Spitzbergen, as recorded by Nathorst (l.c.), Gunnar Andersson and Hesselman (l.c.); according to these authors the following latitudes may be quoted:

Lycopodium Selago and *Equisetum variegatum* 80°
Cystopteris fragilis 79° 15′
Woodsia glabella 78° 40′
Equisetum arvense 78° 30′
E. scirpoides 77° 30′

With regard to the distribution farther south, we see from the table (Table 2), that with the exception of *Lycopodium alpinum* and *Isoëtes* all the other Pteridophyta have been found on this continent, south of the arctic circle, and notably in the mountains.

Cryptogramma, *Botrychium lanceolatum*, *Asplenium viride*, *Isoëtes*, and *Dryopteris fragrans*, having been recorded from very few and scattered stations, may be treated separately.

With regard to *Cryptogramma acrostichoides*, the distribution of this species extends from lake Huron westward to British Columbia, stretching northward to within the arctic circle (Macoun l.c.), and according to Gray (l.c.), it is known also from Colorado and California. Another species, *C. Stelleri* (Gmel.) Prantl (*Ullosurus Stelleri* Rupr.) occurs also on this continent from Labrador to British Columbia, south to Illinois and northern Pennsylvania; it occurs

also in eastern Siberia and in the Baikal mountains. Finally, if *Pellaea dense* Hook. is also to be referred to this genus, we have a third species distributed from Quebec to British Columbia. The geographical centre of the genus appears thus to have been located on this continent, but south of the arctic regions.

Typical *Botrychium lanceolatum* is a native of Greenland (61° N. L.) and arctic Scandinavia, and also of Dovre, Herjedal, etc., but is on our continent represented by a variety *angustisegmentum* Pease and Moore. It is evidently of Scandinavian origin. The same appears also to be the case of *Asplenium viride*, and its present southern distribution may indicate that it is one of the northern plants which were left over on the southern mountains while the others retreated to their northern homes.

With regard to *Isoëtes echinospora*, its present distribution: Iceland, Faeroe Islands, Scandinavia, Denmark, and Central Europe, seems to indicate that the geographical centre of this species is located in Central Europe, and that the dissipation to the north, to Greenland and Finmark, took place during the glacial epoch.

Dryopteris fragrans is, on the other hand, a genuine arctic type, which was evidently more widely distributed in the polar regions before the glacial epoch, and its occurrence in arctic Siberia, Ural, and Altai, and also in Kamtchatka, might indicate a former, circumpolar distribution.

Before we can consider the distribution in general of all the other Pteridophyta, enumerated in Table 2, we might add the following ten species which have been found in the arctic regions of Scandinavia and Russia, but not in arctic America; by adding these, we shall have, I believe, an approximately complete list of all the arctic Pteridophyta. The number of species is: Filices, 24; Equisetaceae, 5; Lycopodiaceae, 3; Selaginellaceae, 1; and Isoëtaceae, 1.

TABLE 2A.

Geographical distribution of arctic Pterid phyta absent from arctic America.

	Arctic Scandinavia	Arctic Russia	America south of the arctic region	Alps and Pyrenees	Ural	Caucasus	Altai and Baikal mts.	Kamtchatka
Polypodium vulgare L.	•	•	•	•	•	•	•	•
P. rhaeticum L.	•	•				•		
Asplenium Filix femina (L.) Bernh.	•	•	•	•	•	•	•	
A. septentrionale Sw.	•		•	•	•	•	•	
A. crenatum Fr.		•					•	•
Cystopteris montana Bernh.	•		•	•				•
Alloeurus crispus Bernh.	•	•		•				
Dryopteris Filix mas (L.) Schott	•	•	•	•	•	•	•	
Onoclea Struthiopteris (L.) Hoffm.		•	•	•	•	•	•	•
Botrychium matricariaeoides (L.) Willd.		•	•	•				

As may be seen from these tables, most of the species have also been reported from the mountains farther south; not less than 29 from America, 25 from Altai, 24 from the Alps and Pyrenees, 18 from Ural and Kamtchatka, and 16 from Caucasus. Among these, the five species which are absent from America are:

Polypodium rhaeticum, *Asplenium crenatum*, *Allosurus*, *Lycopodium alpinum*, and *Isoetes*. Absent from the European Alps, but recorded from Altai are: *Dryopteris fragrans*, *Asplenium crenatum*, *Woodsia glabella*, *W. hyperborea*, *Equisetum scirpoides*, and *E. variegatum*. Finally, absent from Altai but reported from the European Alps are: *Cystopteris montana*, *Allosurus*, *Asplenium viride*, *Blechnum*, and *Botrychium matricarioides*.

It is interesting to notice that, if those most widely distributed had also been reported from arctic Siberia, 17 of the species enumerated on Table 2 would be circumpolar. Their total absence from that region makes a wide gap in their northern distribution. And naturally so, for the Siberian tundra would never make a home suitable to ferns. Nevertheless, on the southern border, in the regions of Altai and Baikal, we have seen that not less than 25 species of arctic Pteridophyta have become established, and strange as it might appear, associated with flowering plants, many of which are known, at present, to occur in arctic Siberia, and even to be circumpolar.

Otherwise with Europe and North America. We have seen that the distribution of the arctic Pteridophyta, in the temperate regions, notably mountainous, of these continents corresponds well with their northern occurrence. And at the same time we have seen that several of the species are identical with those of the Altai mountains. In other words, there is a striking accordance between the flora of the southern mountains throughout the northern hemisphere and that of the arctic region, as far as the Pteridophyta are concerned. And we have seen also that in the polar regions the ferns and their allies have reached the highest latitudes known for vascular plants. By combining these data relative to their present distribution, I really believe, that most of the arctic Pteridophyta originated in the far north. They cannot possibly be considered as a part of the original alpine Altai flora, as long as we have no trace of their migration from these mountains to the north, such as is otherwise the case of a number of flowering plants, still to be found north of Altai, i.e. in arctic Siberia.

In passing to describe the geographical distribution of the Phanerogams, it will be seen that we are dealing with a group of plants which has become more evenly distributed around the polar regions than the Pteridophyta; thus a number of them are, at present, circumpolar.

Although *Picea canadensis* BSP. (*Abies canadensis* Mill.) does not properly belong to the arctic zone, it deserves mention that it is known to occur in many places far north of the arctic circle in Canada and Alaska. It was found in abundance in two districts explored by the expedition, namely the Mackenzie delta and Coppermine river valley. With regard to the distribution of the species in the Mackenzie delta, Mr. A. H. Harrison has published a map of the delta showing the north limit of the spruce.[1] According to this map the spruce begins a little above Lat. 69° N., at the south point of Richard island, extending from there southeastward to second Eskimo lake, at about Lat. 68° 50′ N., and then northeastward, reaching Lat. 69° 35′ N. near the south shore of Liverpool bay. The spruce thus comes within ten miles of the coast on the west side of Franklin bay, on the Horton river, and within thirty or forty miles of the coast on the Anderson river, south of Liverpool bay. The most northern bunch of spruce trees in the Coppermine river region is, according to Dr. R. M. Anderson (in Stefansson: My Life with the Eskimo, l.c.p. 445), within six miles of the coast on a little creek valley several miles east of the Coppermine river, but these trees were scrubby and dwarfed. In a small, isolated grove of spruce near Kendall river, a few miles west of the Coppermine river, and not far from Dismal lake, Dr. Anderson measured one tree, which was four feet and six inches in circumference five feet above the ground and above the bench roots; the same

[1] "In Search of a Polar Continent." 1905–1907. London, 1908.

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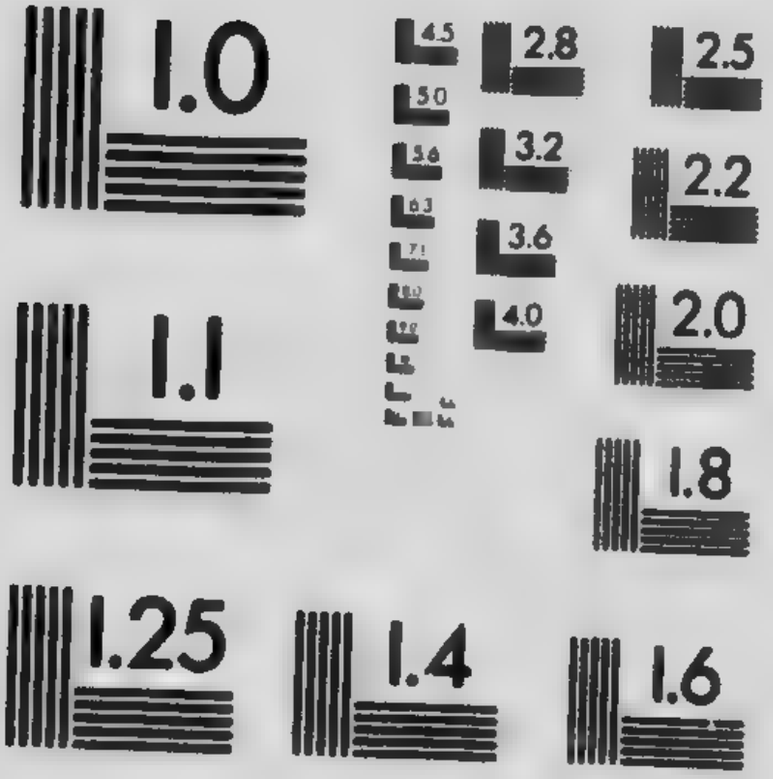

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tree was five feet in circumference three feet above the ground. Dr. Anderson furthermore states that none of these trees were very high, but were mostly straight-grained, and not twisted spirally as are most of the spruce in this region.

These northern groves of spruce have been mentioned already by the earliest expeditions which visited the lower Coppermine river, notably by Samuel Hearne (1769-1772), Captain John Franklin (1819-1822), and Dr. John Richardson (1825-1827). In his "Arctic Searching-Expedition, 1848-1849," Dr. John Richardson gives an interesting description of the spruce, as he found it above "Bloody Falls" on the Coppermine river, which may be quoted as follows: "(Crossing overland from west of the mouth of Coppermine river to above Bloody Falls) we encamped on the 7th September on coming to a clump of stunted white spruce . . . . In the existence of many scattered stumps of decayed spruce fir trees, and the total absence of young plants one might be led to infer that of late years the climate had deteriorated and that the country was no longer capable of supporting trees so near the sea coast as it had formerly done. The largest trees in the clump in which we bivouacked had a circumference of 37 inches at the height of four feet from the ground. Its annual layers were very numerous and fine, and indicated centuries of growth, but I was unable to reckon them. This place lies in Lat. 67° 22′ N. . . . . One circumstance which came under my observation, and has been cursorily alluded to, is the existence of very ancient stumps of trees, either solitarily or grouped in various places of the barren grounds, seemingly the vestiges of the forest which had spread more widely over the country some centuries ago than in the present day. . . . . On the sheltered banks of rivers, even in the barren grounds, clumps of living trees occasionally occur, but the stumps I speak of stand often on the exposed side of a hill, and indicate a deterioration of the climate, however that may have been produced. We saw no young firs growing up in such situations to leave similar vestiges in a future age. . . . . Within the Arctic circle it (the white spruce) seldom exceeds 40 or 50 feet in height, though in ravines where it is well sheltered, and has a suitable soil it attains twice that altitude. Its age in these high latitudes exceeds 400 years before it shows signs of decay." Similar observations were made by Mr. Frits Johansen, who has published an interesting article on "The Forest's Losing Fight in Arctic Canada,"[1] in which the author calls attention to the scarcity of very young spruce trees in this northern limit of their growth. Mr. Johansen attributes this to the intense cold and the sweeping winds in the winter killing off most of the small seedlings which may have developed during the summer. This explanation seems well founded by the fact that even the small and stunted trees were found to be about half a century old, while the largest trees would reach an age of almost 500 years. Furthermore, Mr. Johansen made the interesting observation that forest insects are principally responsible for the killing of the trees or tree parts in the lower Coppermine river, a fact which has, so far, escaped the attention of the various explorers who have visited the region from time to time. As a matter of fact, the very isolation and exposure of the individual trees here makes them an easy mark for attacks by forest insects, which by living under the bark are less influenced by the shortness of the summer season.

As to the occurrence of spruce on the arctic side of the mountains west of the Mackenzie delta, Dr. R. M. Anderson writes: "Information which I have obtained from natives and reliable white hunters and prospectors agrees that west of the Mackenzie delta there are spruce trees on Babbage river (back of Kay point, Y.T.), and on Firth river (the so-called 'Herschel Island river,' on both sides of the International Boundary), but none on rivers west of these.

[1] Canadian Foresty Journal. Ottawa, July, 1919, p. 303.

Some Colville river Eskimos told us that there are a few spruce on the north side of the mountains near the head of the Itkillik river, a large tributary of the Colville river on its eastern side. No other rivers on the north slope of Endicott range have coniferous trees."

Fig. 1. *Picea canadensis* and *Salix* on creek slope, tributary to Coppermine river below Sandstone rapids. Feb. 15th, 1915. (Photo by F. Johansen.)

Fig. 2. *Picea canadensis* in creek bed, tributary to Coppermine river, below Sandstone rapids. February 15th, 1915. (Photo by F. Johansen.)

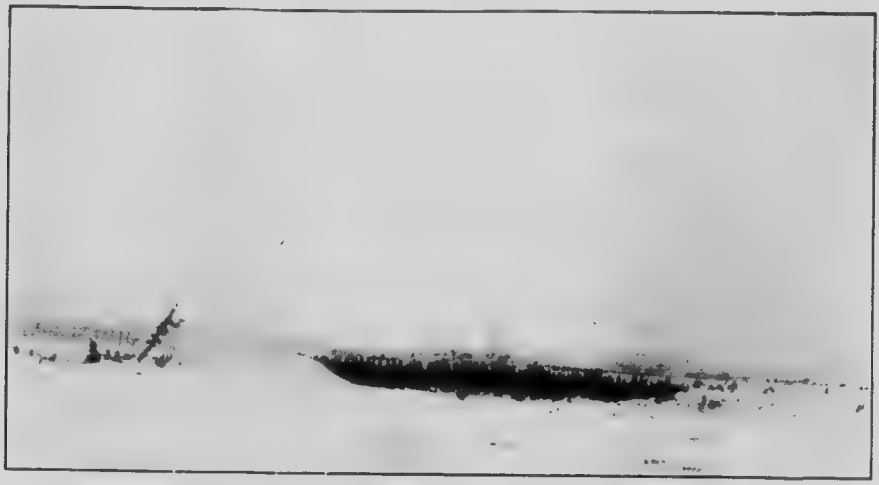

Fig. 3. Grove of white spruce (*Picea canadensis*) southeast of Sandstone rapid, Coppermine river. The most northern dense grove in this region, a thick stand being found only where protected from sweeping winds and with good exposure to the sun. February 15, 1915. (Photo by R. M. Anderson.)

With respect to the general distribution of *Picea canadensis*, Sargent [1] gives this as follows: "The White Spruce inhabits the banks of streams and lakes and the borders of swamps, in rich moist alluvial soil, ocean cliffs, and less commonly at the north rocky slopes of low hills; it ranges from the shores of Ungava bay in Labrador westward to those of Hudson bay, and from the mouth of Seal river not far to the north of Cape Churchill, it is scattered along the northern frontier of the forest nearly to the shores of the Arctic Sea, and, crossing the continental divide, reaches Bering Strait in 66° 44′ north latitude. Southward it extends down the Atlantic coast to southern Maine, growing often close to the shore, and to northern New Hampshire, Vermont, New York, Northern Michigan and Minnesota and the Black Hills of Dakota, and through the interior of Alaska and along the Rocky Mountains to northern Montana."

The accompanying photographs were taken by Dr. Anderson and Mr. Johansen and give an excellent idea of the growth of the spruce in the far north.

Among the 20 species of Gramineae, enumerated on the geographical table (Table 1), ten are circumpolar: *Hierochloë alpina*, *Alopecurus Arctagrostis*, *Trisetum*, *Catabrosa*, *Poa arctica*, *Dupontia*, *Festuca ovina* and *F. rubra*, and finally *Arctophila*. With the exception of *Dupontia*, *Arctophila*, and *Catabrosa*, all the others have also been reported from the Altai mountains; *Trisetum*, *Poa arctica*, and the two species of *Festuca* are known also from the Himalayas. With regard to their occurrence in the Alps and Pyrenees, only *Trisetum* and the two species of *Festuca* have been reported from these mountains. In the Rocky mountains south of the arctic region we have only four of these represented, namely, *Trisetum*, *Catabrosa*, *Poa*, and *Festuca ovina;* this seems somewhat peculiar since they have been found on the American coast of Bering strait, and with the only exception of *Dupontia* and *Alopecurus*, they have also been reported from the Asiatic coast. However, *Dupontia*, *Arctophila*, and *Arctagrostis* are almost exclusively confined to the arctic regions, and the presence of *Arctagrostis* in the Altai mountains may indicate that the genus reached these mountains during the glacial epoch and remained there. Besides these circumpolar species, all of which undoubtedly originated in the arctic regions, the following may also have had their centre located in the north, viz.: *Hierochloë pauciflora*, *Calamagrostis*, *Elymus*, *Poa glauca*, *P. abbreviata*, and the species of *Glyceria*.

[1] The Silva of North America, Vol. XII. Boston, 1898.

Common to both coasts of Bering strait, and furthermore recorded from Altai mountains and the Himalayas, we have thus in *Festuca altaica* a southern type, which evidently was one of those that accompanied the arctic plants on their retreat to the north during the glacial epoch. *Hordeum jubatum* may well be considered as an introduced weed.

Among these arctic Gramineae two species are of special interest: *Poa abbreviata* and *Calamagrostis purpurascens;* while both are undoubtedly of arctic American origin, the former has also reached Spitzbergen, and the latter is not so very rare in the alpine region of the Rocky mountains (Colorado); besides that it occurs in Greenland, and on the American coast of Bering strait. With reference to *Poa abbreviata*, Nathorst (l.c.p. 287), mentions this in connection with *Glyceria angustata* from Okhotsk, and *Alsine Rossii* from the Rocky mountains, as being the only species which Spitzbergen has not in common with Nova Zembla and Scandinavia. The occurrence of these three species in Spitzbergen is very strange, inasmuch as we are entitled to believe that the flora of Spitzbergen originally came from Scandinavia and Nova Zembla in post-glacial times, when these stations were connected with each other by "land."

Calamagrostis purpurascens is one of the many American species which found their way to Greenland.

Although the large family of Cyperaceae is relatively poorly represented on the arctic coast of our continent, some of the species which have been collected are, nevertheless, of some interest from a geographical viewpoint. *Elyna Bellardii*, for instance, shows a distribution of enormous extent, viz.: the arctic regions of America, Greenland, Scandinavia, Russia, and Siberia; farther south it is alpine in the Rocky mountains (Colorado), and it also occurs in the Alps and Pyrenees, Caucasus, Turkestan, Altai, Davuria, and Iceland. It is on this continent associated, to some extent, with a *Cobresia, C. caricina* Willd., which is also arctic-alpine, and known from several of the same countries, and also from the Himalayas. Of the 29 species known of these two genera, the 27 are exclusively Asiatic, and principally natives of the Himalayas.

Elyna is thus the only one of these which may be looked upon as an arctic, circumpolar type, and it would seem very strange if the species had really originated from one single centre of distribution. No doubt the Altai mountains were an important centre for its distribution in Asia, and it might have reached the European mountains by the way of Turkestan and Caucasus. But with regard to the occurrence on this continent, and especially in the Rocky mountains, a second centre may have been located there, from where it thus became distributed farther north during the glacial epoch. Moreover, *Elyna* is, as stated above, on this continent accompanied by *Cobresia caricina*, and besides this, a second species, *C. elachycarpa* Fernald, has been detected in Maine. This species, however, is by Kükenthal referred to the genus *Carex*, for no other reason than "Area geographica *Cobresiae* speciem excludere videtur." Nevertheless, there is a *Claytonia* in New Zealand, a *Podophyllum* in the Himalayas, a *Jeffersonia* in Manchuria, etc.

Of the twelve *Carices* collected, six are circumpolar, and we have seen from the introduction the remarkable geographical range exhibited by *Carex incurva;* nevertheless, I am most inclined to consider these circumpolar species as having originated in the north, in the polar regions: a similar northern centre may also be attributed to the non-circumpolar, but exclusively arctic *C. reducta, C. stans*, and *C. compacta*.

But with reference to *C. scirpoidea*, this did undoubtedly originate in the Rocky mountains, where it is more amply represented than anywhere else, and accompanied by the variety *stenochlaena*, and in the Coast range, California, by the variety *gigas*. The fact that *C. scirpoidea* does also occur in Greenland,

Iceland, and Norway, seems to support the theory, proposed by Nathorst, that the American element in the European mountains may have reached these by way of Greenland during the glacial epoch.

C. rupestris, not being circumpolar, but represented on our northern coast, in Greenland, Spitzbergen, Scandinavia, Nova Zembla, Iceland, the Alps and Pyrenees, Caucasus, Altai, besides the Rocky mountains, as far south as Colorado, cannot possibly have acquired such wide, but more or less disconnected range, from one single centre, located in the south, or in the north either.

Carex vaginata is in the table marked down for: islands of the arctic American archipelago, arctic Scandinavia, arctic Russia, Iceland, Alps and Pyrenees, and both coasts of Bering strait. The species is, moreover, widely distributed in the mountains of Central Europe; it occurs also in West and East Siberia, in the Amur district, and in northern Japan. Several varieties have been described, viz.: *distracta* Norman from Finmark, *pauciflora* (Wahlenb.) Ands. from East Siberia, "Lena," *Gruetteri* Aschs. et Graeb. from the Baltic provinces, *Petersii* from Kamtchatka, *altocaulis* Dew. from Labrador to British Columbia, the northern Atlantic States, and also Michigan and Minnesota. It would thus appear as if the centre of distribution of this species may be located south of the arctic region; the occurrence of certain varieties in the south speaks also in favour of this supposition.

Furthermore, *Carex vaginata* is a member of the *Grex Cenchrocarpae*,[1] the species of which are indeed southern types; only a very few have reached the polar regions, viz.: *C. bicolor* All., *C. livida* Willd., and *C. vaginata*. However, the distribution within the arctic region of these species is very limited.

According to these data, the arctic Gramineae and Cyperaceae do exhibit a much wider distribution in the north than in the south, with only a very few exceptions, namely: *Festuca altaica*, *Elyna*, *Carex vaginata*, *C. rupestris*, and *C. scirpoidea*. And, furthermore, there are several members of these families which, according to our present knowledge, are endemic to the arctic regions, viz.: *Hierochloë pauciflora*, *Poa abbreviata*, *Arctophila*, *Dupontia*, *Glyceria*, *Elymus*, *Carex stans*, *C. subspathacea*, *C. reducta*, and *C. compacta;* in all 12 species (*Glyceria* with 3), which are confined to these regions and must naturally have developed there. *Arctophila* and *Dupontia* are both well marked, and indeed, quite characteristic genera, and none of their species are known except from the arctic regions. Furthermore, *Hierochloë pauciflora* and *Poa abbreviata* are both excellent species, and may well be looked upon as genuine arctic types, i.e. "types" with regard to their morphological structure and geographical distribution.

The species of *Glyceria* are also interesting from this point of view; their habit is very characteristic, when compared with that of most of the other species of the genus and, as has been shown in the chapter dealing with the morphological structure of the arctic plants, *G. vilfoidea* shows a very singular structure of the stolons, which is almost unique. But with regard to the Cyperaceae, even if *Eriophorum*, at least some of the species, may have originated in the arctic, the singular structure of the fruit constitutes no character which the genus does not share with its southern representatives. And among the *Carices* there seems to be no type especially characteristic of the arctic regions; the genuine arctic species, not only those as are circumpolar, but also those as are confined to the polar regions, resemble their southern allies, alpine as well as lowland types.

The temperate regions of both Worlds are the principal home of *Juncus* and *Luzula:* they have developed there and acquired a habit and structure which marks them wherever they occur. However, there is also an arctic element of both genera which seemingly originated in the far north and of which several types have entered the alpine regions in the south during the glacial epoch; some, but only a few, species are endemic to the arctic regions.

[1] Holm, Theo. Greges Caricum. Am. Journ. of Sc., Vol. 16. New Haven, 1903, p. 458.

The lowland, we might perhaps say the "maritime" and "paludine," habit of *Juncus* is in striking contrast with the sylvan or frequently mountainous habit of *Luzula*, and wherever arctic elements of the genera meet, such as is only the case in the higher mountains, the species seemingly prove to be of high-northern, i.e. of arctic origin.

Very few of the Juncaceae are circumpolar, viz.: *Juncus biglumis*, *L. zula spicata*, *L. hyperborea*, and *L. parviflora*. Nevertheless, six species have been reported from Spitzbergen, from latitudes as high as 78° 30′ to 80° 30′, and these are: *Juncus biglumis*, *J. triglumis*, *J. castaneus*, *Luzula Wahlenbergii*, *L. hyperborea*, and *L. nivalis*. But we know also from Hart's Report on the Botany of the British Polar-Expedition of 1875-76 (l.c. p. 19), that *Juncus biglumis* was collected as far north as 82° 27′, *Luzula arcuata* at 81° 49′, and *L. parviflora* at 72° 20′.

And from the north coast of Siberia (Sibir. Nordkust. Fanerog. Flora) Kjellman has reported: *Juncus biglumis*, *Luzula parviflora*, *L. Wahlenbergii*, *L. arctica*, and *L. arcuata*. A similar high latitude is in Greenland reached by *Juncus biglumis*, 76° 7′; by *J. triglumis*, *J. castaneus*, and *J. arcticus* 70°; and *Luzula spicata* is reported from 76° 7′, and *L. parviflora* from 72° 20′.

In the Alps of Switzerland Heer (l.c.) records the following species: *Juncus triglumis* from an altitude of 8,500 feet, *J. arcticus* from 8,020 feet, *Luzula parviflora* from 9,554 feet, and *L. spicata* from 9,600 feet. On Long's peak in Colorado I collected *Juncus biglumis*, *J. triglumis*, and *Luzula spicata* at an elevation of 12,000 feet, while I did not observe *L. parviflora* above the timber-line, and never above about 10,300 feet.

Finally may be mentioned that four of the species collected by the expedition have been recorded from the Altai mountains, and of these *Juncus triglumis* and *Luzula spicata* have even reached the Himalayas, where they have been observed at elevations ranging from twelve to fifteen thousand feet.

The prevalent arctic-alpine distribution of these Juncaceae may thus indicate either an arctic or an alpine centre. However, the species appear to thrive best in the far north, on the tundra and seashore (*Juncus*), in the mountains (*Luzula*). And it is a notable fact that such types of *Juncus* and *Luzula* as are alpine, but not arctic, are of a habit quite distinct from their arctic congeners. This may be readily seen when we consider, for instance, the alpine species of *Juncus*: *J. xiphioides*, *J. Drummondii*, and *J. Parryi* from the Rocky mountains. And with reference to *Luzula*, the alpine element in Switzerland contains such characteristic types as *L. albida*, *L. nivea*, *L. Forsteri*, *L. pilosa*, etc. In other words, the two sections *Pterodes* and *Anthelaia* of *Luzula* represent the alpine element, while *Gymnodes* is mainly arctic. And I believe such distinction in habit in connection with a circumpolar distribution might indicate that these species belong to the arctic flora rather than being of southern, alpine origin.

According to Bentham and Hooker, the genus *Tofieldia* contains 14 species, two of which are natives of the Andes, while the others are widely distributed in the boreal and temperate zones of the northern hemisphere.

Three of the species are of interest to us from a geographical point of view: *T. palustris* Huds., *T. coccinea* Richards., and *T. calyculata* Wahlenb. Having been collected by the expedition, *T. palustris* is enumerated on Table 1, and the geographical distribution covers part of the polar regions, except Nova Zembla, and we might say also Siberia, since Ledebour credits the species only to Ural (Ruprecht) and Obdorsk (Sujef). Farther south it occurs in the Alps and Pyrenees, but is absent from Caucasus, the Altai mountains and the Himalayas. On our continent the species is distributed from Labrador to the Aleutian islands, and south to Minnesota.

T. coccinea is the only species of the genus which Kjellman has credited to the north coast of Siberia; on this continent, John Macoun (Catalogue, l.c.) gives the distribution as follows: Barren ground from lat. 64° to the shores of

the Arctic sea; about Jasper's Lake, in the Rocky Mountains, and, on the west coast, north of lat. 58°, to Ounalashka, Kotzebue Sound, Chamisso Island, and Cape Lisburne, north-east coast of America. It has also been found in Greenland, on the east coast at 72° 30′ (Dusén), on the west coast at 70° (Hartz), but it is absent from Spitzbergen, Scandinavia, and Russia. In Asia it occurs, as stated above, on the north coast: the mouth of the river Lena, and of the river Olenek, besides in eastern Siberia and Kamtchatka. Toward the south it extends to the Baikal mountains.

Finally, with respect to *T. calyculata* Wahlenb., this species is more southern, and has been reported from South Russia, the Alps and the Pyrenees, Ural and Kamtchatka; however, it occurs also in Sweden, but only on the island of Gotland.

Tofieldia palustris and *T. coccinea* thus inhabit the arctic region of this continent, including Greenland. But while the former extends eastward through arctic Europe to Ural, the latter extends westward through Siberia to the river Olenek (Long. 120° E.). With regard to their southern distribution, *T. palustris* does not extend beyond Minnesota on this continent, while in Europe it reaches the Alps of Switzerland; *T. coccinea* does not extend beyond Canada, while in Asia it extends to the Baikal mountains. While thus the southern distribution of these species corresponds well with the northern as far as concerns Europe and Asia, their absence from the central Rocky mountains seems strange. Furthermore, with regard to the third species, *T. calyculata*, its occurrence in South Europe and Kamtchatka is difficult to combine.

We have thus in the genus *Tofieldia* two decidedly northern species, both represented in Greenland and on this continent, and a southern, *T. calyculata*, which in the Alps of Switzerland is, to some extent, accompanied by the northern *T. palustris*. No doubt the present distribution points toward the north as being the geographical centre of *T. palustris* and *T. coccinea*, but it seems impossible to decide whether the centre was located on the American continent or in Greenland.

Lloydia serotina was collected on the arctic coast; it occurs also in arctic Russia, Nova Zembla, and arctic Siberia, from Jalmal, Long. 70° 30′ E., to Pitlekaj, Long. 173° 24′ W. Farther south it is widely distributed in the Alps and Pyrenees, Caucasus, Altai mountains, the Himalayas, besides in our Rocky mountains, as far south as Colorado. Being absent from the arctic American archipelago [illegible] enland and Scandinavia, *Lloydia* cannot be considered a circumpola[illegible] and the very extensive distribution in the mountains farther so[illegible] licate a southern location of its centre, however, not on this continent. [illegible] rrence of the plant on both coasts of Bering strait seems to indicate the [illegible] ollowed from Siberia to the north of America, and from there to the Rocky mountains. The location of the original centre is difficult to decide, and it seems plausible to suppose that the species developed from two centres, one in the European Alps, another in the Himalayas.

Of the genus *Salix* eleven species were collected on the arctic coast by the expedition, but to these I have added *S. alaxensis*, which was found at King point by the Gjöa expedition; furthermore, I have added *S. polaris* Wahlenb., according to Simmons (l.c. p. 73), who states that a specimen collected by Miertsching at Cape Bathurst represents this species.

Three of these willows are circumpolar, viz.: *Salix glauca*, *S. polaris*, and *S. reticulata*; the absence from arctic Russia makes *S. arctica* non-circumpolar; with regard to *S. ovalifolia* and *S. rotundifolia*, these species are not only absent from Russia, but also from Greenland and the arctic American archipelago.

S. Richardsonii and *S. alaxensis* have been recorded from the arctic archipelago, besides from the American coast of Bering strait; but *S. phlebophylla*, *S. pulchra*, and *S. niphoclada* are known only from the arctic coast, explored by the expedition, and from the American coast of Bering strait. Finally, *S.*

fullertonensis, described from specimens collected at Fullerton, in the Hudson bay region, was also found on the arctic coast by the expedition; the specific name is thus one of the numerous instances that prove geographic names to be misleading, and such names ought always to be avoided.

As to the southern distribution, *S. reticulata* has found its way to the Alps, the Pyrenees, the Rocky mountains (Colorado); it occurs also in the Altai mountains, from where *S. glauca* and *S. arctica* have also been reported.

While thus the representation of the genus *Salix*, as it occurs in the arctic region, is well exemplified by the collection brought home by the expedition, it seems very strange that the common arctic *S. herbacea* L. is not among the species. This species is, as a matter of fact, reported from several stations in the American archipelago, and it is very common in Greenland, between Lat. 60° and 76° 7′ on the west coast, and at about 72° 25′ on the east coast (Dusén); furthermore, it is known from Iceland, Spitzbergen, Scandinavia, arctic Russia, Siberia (Obdorsk, collected by Sujef according to Pallas), but it is absent from the coasts of Bering strait. Further south *S. herbacea* occurs in Labrador, extending from there to summits of the higher Rocky mountains, from Canmore, Alta., to the Selkirk mountains (Lat. 51°) in British Columbia; in Maine it has been found in the alpine region of Mount Katahdin, and in New Hampshire on Mount Washington. In South Europe it occurs in the Alps and Pyrenees, and in Asia it has reached the Altai mountains.

The distribution of *S. herbacea* thus agrees so well with that of *S. reticulata* that it was really to be expected that the species would also be found on the arctic coast.

Considering, however, the species of *Salix*, represented on the coast, and comparing their general distribution throughout the northern hemisphere, it appears as if the genus has a most important centre of distribution in North America, and especially in the arctic region. Undoubtedly the circumpolar as well as several of the other arctic species originated in these regions, and as we know from the writings of Nathorst,[1] *S. polaris*, *S. reticulata*, and *S. herbacea* once inhabited the lowlands of Central Europe, associated with *Betula nana*, *Diapensia*, *Andromeda*, *Ledum*, *Oxyria*, and several other genuine arctic plants. In other words, they are members of the glacial flora, and some are still in existence on the southern mountains.

One species of *Populus* was collected along the Hulahula river, Alaska, and along the lower Coppermine river, Northwest Territories; the specimens consisted of some dead leaves, and some wood and bark. Although the outline of the leaves does not correspond with that of typical *P. tremuloides* Michx., I have nevertheless "ad interim" referred the material to this species on account of the structure of the petiole, which corresponds with that of *P. tremuloides*, it being very distinctly flattened. Owing to the possibility of the specimens being *P. balsamifera* L., as the latter species is known to extend nearly as far north, the following points relative to the distribution of both species may be given. According to John Macoun (Catalogue, l.c. p. 456), *Populus tremuloides* Michx. is one of the most widely distributed of the deciduous trees. It is found on all dry slopes from Newfoundland and Labrador throughout the northern forest region to Alaska. It constitutes the "bluffs" and copse wood scattered over the prairie region, and is a fine large tree in the southern part of the sub-arctic forest. Southwards it extends through the northern States to the mountains of Pennsylvania, northeast Missouri, southern Nebraska, and through all the mountain regions of the west, often ascending to an elevation of 10,000 feet above the level of the sea, to the Sierras of central California, northern Arizona and New Mexico, the high mountain ranges of Chihuahua, and San Pedro Mártir mountain in lower California. (Sargent: Silva. Vol. 9, Boston, 1896)

[1] Nathorst, A. G. Über den gegenwärtigen Standpunkt unserer Kenntniss von dem Vorkommen fossiler Glacialpflanzen. (Bih. K. Sv. Vet. Akad. Hdlgr. Vol. 17, No. 5. Stockholm, 1892.)

Populus balsamifera L., the Balsam poplar, extends even farther north than the Aspen, *P. tremuloides*, and as stated by John Macoun (l.c.p. 456), it attains a great size and height as far north as the arctic circle on the Mackenzie river. From the valley of the Mackenzie river, and from the Alaskan coast, it is distributed through the Hudson bay region and Newfoundland, southwest to northern New England and New York, central Michigan and Minnesota, the Black Hills of Dakota, northwestern Nebraska, northern Montana, Idaho, and Oregon and Nevada, according to Sargent.[1] As far north as Fort Simpson on the Mackenzie, Lat. 62° N., Mr. E. A. Preble (l.c.p. 520) writes that the species is a stately tree, but below that point "rapidly decreases in size, and on the lower Mackenzie and Peel rivers it occurs as a small tree.

"West of the Mackenzie river delta there are said to be poplars on the Turner river (Kongakut) west of Demarcation point; on the Aichillik river, south of Icy reef, on Jago river, south of Martin point; and on the Hulahula, southwest of Barter island. There are said to be no poplars on the north side of the mountains west of the Hulahula river where specimens were taken. All the streams have shrub willows a short distance back from the coast, except the Okpilak, whose name signifies "without willow (*okpik*)". The Sagavanirktok has few willows, while the Canning is said to have willows 15 to 20 feet high and as thick as an ordinary stovepipe, in some of its sheltered valleys." (R. M. Anderson, from field notes.)

While *Betula glandulosa* Michx. was collected at several stations, no specimens of *B. nana* L. were discovered. And the material of the former, though very small-leaved, showed the structure characteristic of the species, especially the branches being densely covered with resinous, wart-like glands. It seems very strange that *B. nana* appears to be absent from the north coast, since the two species actually cover the same area, a little farther south, from Newfoundland and Labrador westward to the Mackenzie river.

Fig. 4. Thicket of small poplars, *Populus tremuloides* Michx., bordered by a common arctic willow, *Salix arctica*. Foothills of Endicott mountains, on Hulahula river, Alaska. One of the very few straggling bunches of poplar on the arctic slope west of the Mackenzie. April 2, 1914. Dead leaves are still hanging on the willows, the nook being well sheltered from winds. (Photo by R. M. Anderson.)

[1] The Silva of North America. Vol. 9, p. 167. Boston, 1896.

Considering the geographical distribution of *B. glandulosa*, it extends from the north coast to both coasts of Bering strait (Kjellman), and to the northeast coast of Siberia, from where Kjellman has recorded it: Pitlekaj Long. 173° 24′ W.; according to this author the variety *sibirica* Ledeb. of *B. nana* is identical with *B. glandulosa* Michx. Towards east *B. glandulosa* is known from south Greenland, where the variety *rotundifolia* Regel is not uncommon, but it is totally absent from Europe. On our continent the species follows the Rocky mountains as far south as to Colorado, where it is mostly subalpine, and where it occurs only as the typical plant. It would thus appear as if the species developed on this continent, and presumably in the northern, though not arctic, zone.

Finally may be mentioned that *Betula papyrifera* Marsh., the Canoe birch, was observed by Dr. R. M. Anderson[1] in the Mackenzie delta; the birch was growing on the east bank of the delta, not farther than 50 miles south of Richard island. It was not very numerous, nor very tall, not over eight or ten feet in height.

No specimens of *Alnus* were collected, but Dr. R. M. Anderson has informed me that *Alnus alnobetula* (Ehrh.) Koch was found many miles north of the limit of spruce in the Mackenzie delta; according to Mr. E. A. Preble[2] this alder occurs throughout the region from the Saskatchewan northward to the tree limit. I presume this *Alnus* is the same as "*A. crata* (Schr.) var. *repens* Wormskj.", which by Kjellman is reported from the Siberian coast, from Bering strait to Ural, and which Lange has credited to Greenland between Lat. 61° 10′ and 67° N.; with respect to its habit in South Greenland Lange writes: "Floret post foliationem, quae mense Junio incipit. Truncus ad 9 ped. altus, et fere brachii crassitie, observantibus Schiödte et Kornerup, occurrit." Preble (loc. cit. p. 525) also gives the hoary alder, *Alnus incana* (L.) Willd., as occurring along the Mackenzie north to Peel river.

According to Gray's New Manual, the specific name *alnobetula* has been changed to *crispa* (Ait.) Pursh, since *A. viridis* of the Manual ed. 6 is not DC., and *A. alnobetula* Am. auth. is not Koch.

"A species of alder was also found growing abundantly on the south side of the Endicott range in Alaska, along the banks of streams tributary to the east fork of the Chandalar and the Sheenjek. The inner bark of this alder is much used by the inland Alaskan Eskimos for staining the flesh side of dressed wolverine and occasionally caribou skins. The outer layer of bark is scraped off, the inner bark removed, cut into small bits, moistened with water and applied to the skins, the resulting colour being a burnt sienna similar to the ochre-stained skins of the Siberian Eskimos (R. M. Anderson, notes).

Covering the immense area [illegible] and southern zones, as given in the accompanying table (Table I), we have [illegible] *Polygonum viviparum* and *Oxyria* two genuine arctic types of circumpolar distribution. On the north coast of Siberia they both were collected by [illegible]an, *Oxyria* between Long. 68° E. and Long. 173° 24′ W., and the *Polygo*[illegible]tween Long. 80° 58′ E. and Long. 173° 24′ W.; *Oxyria* was even among the [illegible] which this author collected on the northernmost point of Asia: Cape [illegible]a, Lat. 77° 36′. They are also among the plants growing nearest to [illegible]h having been recorded from Lat. 82° 27′ N. (Hart); in the mountains [illegible]ugh they ascend to an elevation of from 9,500 to 10,000 feet in the Alps [illegible]tzerland (Heer); in the Rocky mountains, Colorado, they both occur at 14[illegible] feet, and in the Himalayas they even reach an elevation of from 10,000 to 15[illegible]0 feet (Hooker).

Oxyria is monotypic; *P. viviparum* is of [illegible]mall section *Bistorta*, of which, furthermore, *P. Bistorta* was collected by the [illegible]tion, a near ally of the latter is *P. bistortoides* Pursh, a native of the Rocky [illegible]tain[illegible]nd frequent in the alpine region as far south as Colorado. But [illegible]ies of this

[1] Stefansson, V. My Life with the Eskimo. New York, 191[illegible]
[2] A Biological Investigation of the Athabaska-Mackenzie Reg[illegible] Dept. of Agric., Washington, 1908, p. 525.)

section which is much more closely related to *P. viviparum*, and which shows the same peculiar transformation of the flowers into bulblets, *P. Macounii* Small. This interesting species was detected by James M. Macoun on St. Paul island, Bering sea.

Oxyria and *Polygonum viviparum* evidently originated in the polar regions; during the glacial epoch they became distributed farther south, where they are still in existence, especially in the alpine regions. *P. Bistorta*, on the other hand, may be regarded as a southern type, as one of those which accompanied the arctic flora on its retreat to the north. The fact that *P. viviparum* and its near ally *P. Macounii*, besides *P. Bistorta*, and *P. bistortoides*, are all indigenous to this continent seems to indicate that the section *Bistorta* must have an important centre of distribution in the northernmost part of America, especially in the northwestern corner.

Koenigia islandica L. was not collected by the expedition, and in North America it is known only from some of the islands of the arctic archipelago, from Unalaska, and, according to Macoun, from "Moist mountains north of Smoky River, Lat. 54° (Drummond)." It is one of the very few arctic plants which are annual, and its geographical distribution may be of interest to students of arctic botany. The species is almost circumpolar, since it has been recorded from Greenland, Spitzbergen, arctic Scandinavia, arctic Russia, Nova Zembla, and, as mentioned above, from some of the islands of the arctic archipelago. But it is not among the plants which Kjellman has recorded from the north coast of Siberia, and Ledebour cites no stations from arctic Siberia either; farther south *Koenigia islandica* is known from Altai and Baikal. On the east coast of Greenland it reaches as far north as Lat. 74° 30′ (Dusén), and it is not uncommon on the west coast between Lat. 60° and 72° 48′.

Koenigia is not monotypic, a second species being indigenous, or let us say, endemic to the Himalayas, and this second species is also an annual. We have thus in the genus *Koenigia* two species, exhibiting such extremely different distribution as almost circumpolar (*K. islandica*), and endemic to the Himalayas (*K. nepalensis* Don).

The Caryophyllaceae are well represented in the arctic region, and of the 13 species known from the north coast, six are circumpolar; according to Hart (l.c. p. 19), some of these plants are among those reported from the farthest north, for instance, *Cerastium alpinum* Lat. 82° 50′; *Alsine verna* and *Stellaria longipes* Lat. 82° 27′; *Lychnis apetala* Lat. 81° 52′; *L. affinis* Lat. 81° 76′; *Silene acaulis* Lat. 81° 40′; *Stellaria humifusa* Lat. 78° 18′; *Alsine arctica* Lat. 72° 20′, etc. In the Alps of Switzerland *Silene acaulis* ascends to an altitude of 9,500 feet, and *Cerastium alpinum* to 8,500 feet, according to Heer (l.c.), in the Rocky mountains of Colorado I collected these two plants at an elevation of between 12,500 and 13,000 feet. While none of these arctic species have been found in the Himalayas, Hooker (l.c.) mentions that the high-northern *Cerastium trigynum* does occur in West Himalaya at an elevation ranging from 11,000 to 17,000 feet.

With the exception of the monotypic *Merckia*, the other genera are widely distributed farther south, and while these: *Silene, Lychnis, Stellaria, Cerastium*, and *Alsine*, are mostly lowland plants in the Old World, Europe and Asia especially, they are in North America represented by species which are principally mountain plants. For instance, of the 42 species of *Silene* credited to North America according to the Synoptical Flora, 12 species inhabit the Coast range (California), 6 the Cascade mountains, 10 the Rocky mountains, and 4 the Appalachian mountains.

Of the 12 species of *Lychnis*, 5 species inhabit the Rocky mountains, and one the Appalachian mountains; of *Cerastium*, 17 species are known from this continent, and 5 of these inhabit the Rocky mountains, and 2 the Appalachian mountains; furthermore, with regard to *Stellaria*, 23 species are recorded from

North America, of which 3 inhabit the Coast range, 1 the Cascade mountains, 6 the Rocky mountains, and 8 the Appalachian mountains; finally, of our 10 species of *Alsine*, 2 occur in the Coast range, 3 in the Cascade mountains, 5 in the Rocky mountains, and 4 in the Appalachian mountains.

The general distribution of the number of species may be seen from the accompanying table (Table 3). Considering the fact that the column "Mountains of North America" comprises the Coast range, the Cascade mountains, the Rocky mountains, and the Appalachian mountains, the number of species is remarkably small as compared with Altai, and especially with Caucasus, so far as concerns *Silene* and *Cerastium* especially. The number of species from the Alps and Pyrenees is also small as compared with Altai and Caucasus. With regard to the number of species endemic to Caucasus, there are 15 species of *Silene*, 9 of *Cerastium*, 7 of *Alsine*, and 2 of *Stellaria*; endemic to Altai are 4 species of *Stellaria*, 2 of *Cerastium*, and 1 of *Lychnis*.

TABLE 3.

Distribution of some Caryophyllaceæ in the mountainous and arctic regions of both Worlds.

	Mountains of North America	Altai mountains	Caucasus	Alps of Switzerland	Pyrenees	Arctic Scandinavia	Arctic Russia	Arctic Siberia
Silene	32	21	38	6	6	4	6	1
Lychnis	6	3	1	....	....	3	3	1
Alsine	14	4	12	8	6	3	2	4
Stellaria	18	14	6	3	....	8	6	2
Cerastium	7	9	26	4	4	5	4	2

And as may be seen from the same table (Table 3), the contingent of these mountains to the arctic Flora is very small; still, as has been mentioned above, the Caryophyllaceæ are quite frequently met with in the arctic region, and six of those collected by the expedition are even circumpolar and extend very far north. It would thus appear as if these circumpolar species besides *Stellaria longipes* originated in the arctic regions, where they are better represented than anywhere else farther south. However, *Halianthus*, although being circumpolar, must not be included, since it is a lowland plant inhabiting the seashore farther south: the migration of this plant to the polar regions must undoubtedly have taken place at the same time as so many of the other southern species accompanied the arctic on their retreat to the north.

Merckia physodes is undoubtedly a genuine arctic type, known only, so far, from Alaska, Eschscholtz bay and Norton bay to Point Barrow, Mackenzie delta, and northeastern Siberia, Konyam bay, and mouth of the river Kolyma. *Alsine arctica* and *A. macrocarpa* are both recorded from the north coast of Siberia by Ledebour and Kjellman, and the former has also been collected in the Altai mountains and in Kamtchatka.

Very remarkable is the distribution of *Cerastium maximum* L. (*C. grande* Greene). This species has been reported from arctic Siberia: Mouth of the river Kolyma (Angustinovicz), and Pitlekaj (Kjellman); furthermore, from several stations in the Altai and Baikal mountains, from the arctic coast of this continent, from Yukon (Hunker creek), and finally from as far south as Caucasus.

By considering the table (Table 3), it appears as if Caucasus and the Altai mountains constitute a most important centre for the development and distribution of the Caryophyllaceae, especially the genera *Silene*, *Alsine*, and *Cerastium;* however, only so far as concerns the mountainous species, for the majority of the members of the family are lowland species indigenous to the temperate zones of Europe and Asia.

Among the Ranunculaceae, *Caltha palustris* is in the arctic regions nearly always represented by the variety *radicans* (Fr.) Hn., and is circumpolar, being absent only from Greenland and Spitzbergen; it is not by Ledebour credited to arctic Siberia, but Kjellman collected the plant at Irkajpi, Long. 179° 25′ W., on Preobrascheni island, Long. 113° 10′ E., and at Dickson's harbour, Long. 80° 58′ E. Being by far more abundant and typically developed in the temperate regions of both Worlds, and especially in the lowlands, the geographical centre must be sought in these regions, in Europe or Asia.

TABLE 4.

Geographical distribution of the genus Anemone in North America.	Atlantic slope	Rocky mtns.	Pacific slope
Sectio: Pulsatilla—			
A. hirsutissima (Pursh) MacM..		•	
Sectio: Preonanthus—			
A. occidentalis Wats.		•	•
Sectio: Anemonanthea—			
A. parviflora Michx.	•	•	•
A. Drummondii Wats.		•	•
A. decapetala Ard.		•	
A. sphenophylla Poepp.		•	•
A. caroliniana Walt.	•		
A. deltoidea Hook.			•
A. Richardsonii Hook.		•	•
A. quinquefolia L.	•		
A. oregana Gr.			•
A. Lyallii Britt.			•
A. trifolia L.	•		
Sectio: Anemonospermos—			
A. multifida Poir.	•	•	•
A. tetonensis Port..			•
A. cylindrica Gr.	•	•	
A. virginiana L..	•	•	
A. canadensis L.	•	•	
Sectio: Omalocarpus—			
A. narcissiflora L.		•	•

The genus *Anemone* is in the polar regions represented by the sections: *Pulsatilla*, *Preonanthus*, *Anemonanthea*, *Anemonospermos*, and *Omalocarpus;* no other sections are represented on this continent. However, the distribution is so extremely scattered in the arctic regions that it seems necessary briefly to discuss the distribution of the genus farther south before outlining the occurrence

in the north, in the arctic regions. De Candolle is the author of these sections,[1] and there is only one more, *Pulsatilloides*, with two species, both from Cape of Good Hope. From the table (Table 4), it will be seen that *A. hirsutissima* is the only member of the section *Pulsatilla* represented on this continent. According to Gray (Synopt. Flora l.c.) *A. hirsutissima* is identical with *A. patens* L. var. *Wolfgangiana* Regel, which is also recorded from several stations in the Old World, viz.: Sweden, Germany, Russia, Altai, and Baikal; the only place, however, where it extends beyond the arctic circle is on the north coast of this continent. The section is much better developed in Europe, from where six species have been recorded, three of these being also indigenous to Siberia. *Anemone parviflora* extends from Labrador and Anticosti to the Pacific slope, while *A. Drummondii* does not occur on the Atlantic slope. With regard to *A. Richardsonii*, this has been collected on the arctic coast, on the islands of the arctic American archipelago, and at a very few stations on the west coast of Greenland; by Macoun the distribution in Canada is given: "Shores of Hudson's Bay; barren ground, Rocky Mountains, from Lat. 55°-68°, in wet, mossy ground (Richardson, Drummond); York Factory (R. Bell)." Moreover, it occurs on both coasts of Bering strait: Port Clarence, St. Lawrence bay and Konyam bay (Kjellman); it has also been found in "terra Tschuktchorum" (Maydell). None of the other members of *Anemonanthea* extend to the arctic region of this continent, while in Europe *A. nemorosa* L., and *A. ranunculoides* L. have both been recorded from arctic Scandinavia. Among the southern types of this section we notice (Table 4) that there is on this continent a small group of species which show a distinct analogy to a corresponding group in Europe and Asia. I think especially of *A. quinquefolia*, *A. oregana*, *A. Lyallii* and *A. trifolia*, and the northern *A. Richardsonii*, on this continent, and of *A. nemorosa* L., *A. ranunculoides* L., and *A. trifolia* L. in Europe and Asia. *A. trifolia* is thus common to both Worlds; on this continent it is distributed from "Mountains of S. Pennsylvania to Virginia," while in Europe it occurs in Tyrol, Steyermark, Kärnthen, etc.; in Siberia it is replaced by *A. reflexa* Steph.

It would thus appear as if these two groups of analogous species had developed independently on both continents, since it would be very difficult, if not impossible, to connect the stations so remote from each other. In other words, the American element may have had its origin on this continent.

The section *Anemonospermos* is not represented in Europe, but in Siberia by a single species, *A. dichotoma* L. With respect to the section *Omalocarpus*, only *A. narcissiflora* L. is represented on this continent, and in Europe, while two other species are known from Asia: *A. baikalensis* Turcz. from Baikal, and *A. sibirica* L. from the region of Jenisei; the section is undoubtedly of southern origin, but may have developed from more than a single centre.

With regard to the arctic representation of the genus, it would appear as if the American element did not originally develop in the polar region, but farther south, in the Rocky mountains, from where they migrated to the north when the ice receded, *A. Richardsonii* even entering Greenland. In Europe the two lowland species did evidently reach the arctic region at the same time, while their original home can only be defined as Central Europe.

In comparing the arctic American element of *Ranunculus* with that of Europe and Asia, we notice at once the presence of certain genuine American types on our coast, absent from the Eurasian; conversely some Eurasian types present on the north coast of the Old World, but absent from the North American.

We have thus in arctic Scandinavia and arctic Russia four distinct types: *R. auricomus* L., *R. acris* L., *R. repens* L., and *R. sceleratus* L., none of which are indigenous to North America except perhaps the last one; moreover, *R. glacialis* L., which is known from the east coast of Greenland (about Lat. 74°

[1] Regni vegetabilis systema naturae. Vol. 1, Paris, 1818, p. 189.

30', Dusén), but which has not been found, so far, on the North American coast. With regard to the arctic Siberian element, Kjellman (l.c.) has recorded nine species from the north coast, principally collected by himself on the Vega expedition. These species are: *R. Chamissonis* Schl., *R. Pallasii*, *R. sulphureus*, *R. nivalis*, *R. pygmaeus*, *R. hyperboreus*, *R. affinis*, *R. acris*, and *R. lapponicus*. Concerning the arctic American element, this consists of six species, namely: *R. Purshii* Richards., *R. Cymbalaria* Pursh, *R. Sabinii* R. Br., *R. occidentalis* Nutt., *R. lapponicus* L., and to some extent, *R. affinis* R. Br.

Ranunculus occidentalis Nutt., a near ally of *R. recurvatus* Poir., is a native of open woods and low ground in the northern Rocky mountains, from where it extends to the Alaskan coast and islands, and south to the borders of California. The variety *robustus* Gray has been collected on the Alaskan islands, and on the north coast.

With regard to the representation of the genus throughout the northern hemisphere, the Old World element is quite distinct from the North American. On this continent 53 species are enumerated in the Synoptical Flora, not including 6 introduced species, and not either the genera *Kumlienia*, *Arcteranthis*, *Cyrtorhyncha*, and *Batrachium*. And among these species of *Ranunculus* some certain groups are much better represented on this continent than in Europe and Asia. For instance, the section comprising *R. ambigens* Wats., which corresponds to the Eurasian *R. Flammula* alliance; furthermore, the sections of *R. adoneus* Gr., and of *R. abortivus* L., which do not seem to have any analogous representations in the Old World. On the other hand, the section comprising *R. hispidus* Michx. is well exemplified in the Old World, and more extensively so than on this continent. The circumpolar species: *R. hyperboreus*, *R. pygmaeus*, *R. nivalis*, and *R. lapponicus*, besides *R. Pallasii*, *R. sulphureus*, *R. Sabinii*, and *R. affinis* are, as may be seen from Table 1, much more widely distributed in the polar regions than farther south; some few have extended as far south as the Altai mountains, and some even to the Himalayas. But their principal range lies within the arctic region where they undoubtedly originated. *R. Cymbalaria* does not properly belong to the arctic region, even though it has reached the west coast of Greenland at a very few stations only; the distribution of this species is mainly "sea-shore and margins of salt-ponds in the prairie region of this continent;" however, it has also been recorded from several stations in the Hudson bay region, and even farther north.

While thus the arctic species, with the only exception of *R. Sabinii*, have also been recorded from the Old World, it seems somewhat strange that the American alpine element of the genus is not represented; and the same is the case of the Eurasian alpine element, for the few species enumerated above as having found their way to the arctic region, *R. auricomus*, *R. repens*, etc., are lowland types, and the extension of their southern range northward is evidently of a relatively recent date.

The circumpolar *Papaver nudicaule* is a genuine arctic type which during the glacial epoch became widely distributed in the higher mountains farther south; and although still in existence in the Altai mountains, Dovre mountain in Norway, and in the Rocky mountains as far south as Colorado, there is no trace of the species in the Alps or Pyrenees. It is one of the three plants which have been found north of Lat. 83°, *Saxifraga oppositifolia* and *Alopecurus alpinus* being the two others; it may also be mentioned that *Papaver nudicaule* occurs in western Thibet at an elevation of 16-17,000 feet.

Among the Cruciferae we meet with types of very distinct geographical distribution:

I. Circumpolar: *Draba alpina*, *D. nivalis*, *D. fladnizensis*, and *D. hirta*; *Eutrema*, and *Cardamine pratensis*.

II. Arctic, but not circumpolar: *Lesquerella*, *Cochlearia*, *Draba corymbosa*, *Braya*, *Hesperis*, *Cardamine digitata*, and *Parrya*.

III. Southern, alpine: *Erysimum, Thlaspi.*

IV. A weed: *Sisymbrium.*

Of these the circumpolar, and the arctic but not circumpolar, with the only exception of *Cardamine pratensis*, may be considered as having originated in the polar regions. *Erysimum inconspicuum* belongs more properly to the Rocky mountains where it is associated with several species and more widely distributed.

Cardamine pratensis is circumpolar and, moreover, it is widely distributed through the temperate regions of both Worlds. In the arctic region it has only two congeners: *C. bellidifolia* L., which is circumpolar, and *C. digitata* Richards., which seems to be a rare plant, known only, so far, from the islands of the arctic American archipelago, from both coasts of Bering strait, from the Yukon-Alaskan boundary, Long. 141° W., Lat. 60.02 N., from the Hudson bay region and from the territory explored by the expedition. But farther south the genus is quite rich in species, annual or biennial, as well as perennial. Some of these extend as far south as Cape of Good Hope (*C. anteniquana* Burch. and *C. africana* L.), and Tierra del Fuego "fere sub nive" (*C. glacialis* DC.). And with respect to *C. pratensis*, this species shows a wide distribution in the mountains of Europe and Asia, Caucasus, the Himalayas, Altai, and Baikal mountains; it is, however, absent from the Rocky mountains. A peculiarity of this species is that it sometimes does not develop mature seeds, not even in Central Europe, but that reproduction may take place by means of bulblets developed upon the leaves. In the arctic region this species sometimes does not even reach the flowering stage, as pointed out by Nathorst, for instance in Spitzbergen, and this peculiarity it shares with *Empetrum, Petasites frigida, Ranunculus Pallasii*, and *R. hyperboreus*. Nevertheless, these plants are quite widely distributed in Spitzbergen, and Nathorst explains this by considering the plants to represent remnants of an earlier period when the climate was sufficiently warm to enable them to develop fruit and mature seeds. However, judging from the wide geographical distribution and the abundant representation of the genus in the south, it seems most natural to consider the species as being of southern origin, but that it partook in the migration towards north when the arctic flora retreated.

But it is impossible to decide with any certainty the location of the original centre of this species; it may, however, have been in Central Europe where the species is most abundant and associated with a number of allied species, and also with several of the closely allied genus *Dentaria*. In the United States the species is not so common and mostly restricted to the Northern Atlantic States; on the other hand, there are some allied species in the Western States, for instance *C. rhomboidea* DC. and *C. cordifolia* Gray in the Rocky mountains, besides that several species of *Dentaria* are known from the Atlantic and Pacific slope.

In considering the arctic element in Europe and Asia the Cruciferae are in Finmark represented by not less than 24 species, 8 being introduced weeds, however; in Russia there are 28 species, and in Siberia 20, according to the enumeration in Kjellman's paper (Sibir. Nordkust. Fanerog. Flora).

By looking over the representation of the family on this continent, it is interesting to see how several genera have developed here, being endemic to North America (*Thysanocarpus, Lesquerella, Physaria, Streptanthus, Coulanthus, Thelypodium*, etc.); and among the genera, which are common to both Worlds, several have in America given rise to a relatively large number of endemic species, for instance, *Draba* with 20 species endemic, *Arabis* with 30, *Dentaria* with 9, *Erysimum* with 7, etc.

But from the geographical table (Table 1) it is surprising to see how extremely few alpine, I mean southern alpine, types have entered the polar regions; for the circumpolar must be left out of consideration, and with respect to the simply arctic species, none of these bear any evidence of ever having been more

generally distributed south of the arctic region; moreover, the number of species that occur in Greenland and on this continent only is extremely small: *Lesquerella, Draba aurea, Hesperis, Arabis Holboellii*, and *A. Hookeri*.

By comparing the geographical distribution of the genus *Saxifraga*, we have seen that not less than 7 out of the 15 species collected are circumpolar; and with the only exception of *S. rivularis*, they are, furthermore, widely distributed farther south. Engler,[1] who has arranged the species in very natural sections, attributed the following geographical distribution to those of the species which occur within our region, i.e., the one explored by the expedition.

Nephrophyllum: Of the 19 species, representing this section, 10 occur in the mountains of Spain, south of the Pyrenees, and 6 of these are endemic to these mountains; among the others some few are known from the Alps, Caucasus, the Himalayas, eastern Siberia, the Rocky mountains, and Alaska.

The section *Hirculus* contains 11 species, 10 of which are endemic to the Himalayas; the eleventh species, *S. Hirculus*, shows, as may be seen from the table, an extraordinarily wide distribution throughout the northern hemisphere.

Boraphila with 23 species is mainly Siberian, about 16 species being characteristic of the districts between Altai and Kamtchatka, besides western North America; some other species are more widely distributed on this continent, and 9 of these are endemic; several species are also known from the Himalayas, among which 3 endemic. The section is, furthermore, widely distributed in the arctic region.

While 36 species are attributed to the section *Dactyloides*, most of these are from Spain, Atlas, and the Canary islands; some few are known from the Carpathian mountains and the South American Cordilleras; a very few species occur in the Asiatic mountains, but none in the Himalayas.

With regard to the section *Trachyphyllum*, most of the species are Himalayan, and only a very few have been reported from Altai, Kamtchatka, western North America, and Central Europe.

Of the four species representing the section *Porphyrion*, three are confined to the mountains of Central and South Europe, while the fourth one, *S. oppositifolia*, shows an enormous distribution through the northern hemisphere and is, besides, circumpolar.

The data regarding the distribution of the sections, of which species were collected by the expedition, thus indicate the difficulty in locating the actual centres of their distribution, whether the species originated in the north, notably the arctic region, or in the south. However, with reference to *S. radiata* Small (*S. exilis* Steph.), the very limited distribution points towards the centre having been located in northeastern Siberia, where it is accompanied by a near ally, *S. sibirica*.

S. reflexa Hook., being exclusively arctic and confined to the coast between the Mackenzie and Coppermine rivers, must have originated there. *S. aestivalis* grows on the north coast of Siberia, but is seemingly rare there; from there it extends to Altai and Baikal, and eastward to Kamtchatka, the coast of Manchuria, and St. Lawrence island. On this continent the species has been reported from Alaska, together with the very local *S. Nelsoniana*, as well as from the Rocky mountains, as far south as Colorado, and the Cascade mountains. Being apparently very rare in the arctic region as compared with its distribution farther south, and especially in eastern Asia, I presume the centre of both *S. aestivalis* and *S. Nelsoniana* must have been in northeastern Asia.

With respect to *S. bronchialis*, the very wide distribution of this species in the arctic region of Russia and Siberia, and being so very rare on this continent, absent from Greenland and the arctic American archipelago, seems to indicate that its geographical centre may have been located in Siberia, but not necessarily within the arctic region since the species seems to be quite well distributed

[1] Monogra[illegible] der Gattung Saxifraga. Breslau, 1872.

farther south, for instance, in the Altai and Baikal mountains, Davuria, and Kamtchatka. On this continent it does occur on the arctic coast, but only at a very few stations; from there it extends south to the Rocky mountains in Colorado. Although a near ally of *S. tricuspidata*, the geographical distribution of these does not coincide, for the latter is common in Greenland and on the islands of the arctic American archipelago; it has also been recorded from the Appalachian mountains and the Hudson bay region but not from any stations in the Old World. We have thus two closely allied species, one of decidedly Siberian origin and another, confined to this continent, but both occurring in the arctic region and, so to speak, meeting each other on the coasts of Bering strait. The present distribution of *S. tricuspidata*, notably in Greenland, where it abounds between 60° and 78°18′ N.L. on the west coast, and from 60° to 76° N.L. on the east coast, besides that it seems to be quite frequent on the arctic islands, makes the suggestion very probable, that the centre may be sought there, in the north eastern arctic corner of this continent.

A very strange distribution is exhibited by *S. aizoides*, viz.: many stations in Europe, from the arctic region (Spitzbergen and Scandinavia) south to the Pyrenees and the Alps of Italy and Switzerland; in America from the arctic coast south to 51° N. L. in the Rocky and Selkirk ranges, but absent from Asia except a very few stations in Nova Zembla and Ural. As far as concerns the arctic area covered by this species in Europe compared with the corresponding latitude on this continent, including Greenland, the American area is considerably wider. But the much larger area occupied by the species in temperate Europe, besides the more frequent occurrence of the species, does indicate, I believe, that the species originated there, and possibly in the Alps or Pyrenees.

Being almost circumpolar, the only districts uncovered being arctic Scandinavia and the Russian coast, *Saxifraga flagellaris* may nevertheless be considered as a truly arctic type which originated in the polar regions. It is widely distributed on the arctic coast of this continent, including Greenland; it is known from Spitzbergen and Nova Zembla, and from several stations on the Siberian coast. Farther south it is known from the Rocky mountains (Colorado), Caucasus, Altai and Baikal mountains, and the Himalayas. However, it is true that most of the species of the section *Trachyphyllum* are Himalayan, as pointed out by Engler (l.c.), and, moreover, this peculiar little species is in the Himalayas associated with two others, *S. Brunoniana* Wall., and *S. pilifera* Hook. fil. et Thoms., which exhibit exactly the same habit as *S. flagellaris*, viz.: filiform stolons above ground being developed from the axils of the rosette-leaves, and terminated by a small, leafy rosette. But it would be difficult to imagine that these mountains, the Himalayas, should be the actual centre of a distribution so enormously wide in the polar regions. I am more inclined to believe that *S. flagellaris*, like most of the circumpolar species, originated in the arctic regions, and that it reached the Himalayas by way of the Altai and Baikal mountains. The association with the two analogous types may simply indicate a recent geographical centre of this interesting little group of species, extending as far as Caucasus.

The remaining species of *Saxifraga*: *S. rivularis*, *S. cernua*, *S. Hirculus*, *S. nivalis*, *S. hieraciifolia*, *S. decipiens*, and *S. oppositifolia* are circumpolar, and of these *S. Hirculus* is the only one which has no immediate allies outside the Himalayas, and the species itself is also widely distributed in these mountains, ranging from western Tibet (4,500-5,000 m. above sea-level) to eastern Himalayas, at the same altitude. Considering the fact that the section *Hirculus*, containing 11 species, has 10 of them endemic to these mountains, it is natural to suppose that the Himalayas constitute an important or perhaps the only centre, where the section has developed further. But the actual centre of distribution of the species *S. Hirculus* may not have been located there; it is more natural to suppose that similar to most of the other circumpolar

S. Hirculus originated in the arctic regions. For nowhere where the species occurs does it exhibit any pronounced tendency to vary, except with regard to the foliage: "oblongo-lanceolata," "linearia," "spathulata," etc. By some authors, Lange, for instance (Consp. Fl. Groenl.), the arctic plant is considered as representing a variety "*alpina* Engl." from the Himalayas, but the deviation from the type depends merely upon a dwarfed, more condensed growth, the leaves a little broader, etc. The arctic plant resembles the alpine; it is able to produce flowers and ripen the seed even as far north as Spitzbergen, according to Hesselman (l.c.), although probably not every year.

With respect to *S. rivularis* and *S. cernua*, both being also widely distributed farther south, especially the latter, these species are well adapted to the arctic climate, by developing bulblets which, in the latter, have almost entirely replaced the flowers; in this respect *S. cernua* resembles the arctic form of *S. stellaris*, as described. The geographical centre has undoubtedly been within the arctic regions. The prevalence in the north, together with the circumpolar distribution, seems to indicate that *S. nivalis* and *S. hieraciifolia* are also arctic types and that they originated in the polar regions.

But with regard to *S. decipiens*, it seems somewhat doubtful whether an arctic centre could be credited to this species. We should remember that the section *Dactyloides* is decidedly southern, and *S. decipiens* is, so far as we know, about the only one which occurs in the polar regions and is circumpolar. It has, however, two near allies, the distribution of which reaches far north, namely, *S. hypnoides* L., which is common in Iceland but more widely distributed in southwestern Europe, and *S. silenaeflora* Sternb., known only from arctic and subarctic North America, viz.: Hudson bay region and Alaska.

As far as concerns *S. decipiens*, this polymorphic species is best developed in the mountains of Central Europe, but is totally absent from the Asiatic mountains. Engler (l. c.p. 186) has enumerated several varieties, among which "*groenlandica*" is credited to the arctic regions, and also to Norway, Iceland, and Great Britain; two other varieties, "*caespitosa*" and "*uniflora*," are also credited to the northern regions. But the more evolute forms "*vulgaris*" and "*quinquefida*" are exclusively southern. It would thus appear as if the species had developed in the south, Central Europe for instance, where it is best represented and best developed. Wherever it is met with in the polar regions it is always of a stunted growth and few-flowered, which might indicate that it is a foreigner in these regions, but having adapted itself remarkably to the change of conditions, and having acquired such wide distribution so as to become circumpolar.

Otherwise with regard to *S. oppositifolia*. This species being circumpolar and so well adapted to the arctic climate may, in spite of the enormously wide distribution farther south, be considered as a truly arctic type. The other members of the section *Porphyrion* occur only in the highest mountains of Central Europe, but one of these, *S. biflora* All., has also become distributed as far north as arctic Russia.

From a geographical point of view the genus *Dryas* is very interesting, and in some respects quite remarkable. *D. octopetala* and *D. integrifolia* were both collected by the expedition, while the more southern species *D. Drummondii* Hook. was not met with.

As may be seen from Table 1, *D. octopetala* is not only circumpolar but is also widely distributed farther south, notably in Iceland, Scandinavia, the Alps and Pyrenees, Caucasus, Altai and Baikal mountains, the Rocky mountains south to Colorado, and the Asiatic coast of Bering strait, viz.: St. Lawrence and Konyam bay. *D. integrifolia*, on the other hand, is in the arctic region confined to the shore explored by the expedition, the American archipelago, Greenland, and the coasts of Bering strait. In Canada *D. integrifolia* has been recorded from Island of Anticosti, Labrador, the coasts of Hudson bay, extending westward to Bering strait; its southern limit in the Rocky mountains is: Summit of Moose mountain, Elbow river, at an elevation of 7,500 feet.

But of these *D. octopetala* is very rare on the islands of the American archipelago (Boothia Felix), and on the west coast of Greenland it has only been found at a very few stations between 76° and 79° N. L., while it is frequent on the east coast between 70° and 76° N. L. *D. integrifolia*, on the other hand, is very common on the west coast of Greenland, between 60° and 76° N. L., while it has only been found at a few stations on the east coast, between about 70° and 74° N. L. (Dusén and Hartz); from the islands of the archipelago it has been recorded from many stations.

On the shore between Point Barrow and Bathurst inlet *D. octopetala* was found only near Sadlerochit river, Alaska; by the Gjöa expedition it was found at King point, together with *D. integrifolia* and the forma *intermedia* Nathorst *D. integrifolia* was, on the other hand, collected at many stations along the entire coast explored by the expedition; the intermediate form was found at Port Epworth harbour.

Farther westward, at Port Clarence, *D. integrifolia* was observed by Kjellman to be quite frequent, while the other species seemed to be absent; but on the Asiatic coast of Bering strait Kjellman found both species, and *D. octopetala* was very abundant, the other species very rare. Finally, on the north Siberian coast from 173° 24′ W. L. to 68° E. L. *D. octopetala* is the only species, so far observed, according to Kjellman (Sibir. Nord-Kust. Flora l.c.).

With regard to the third species, *D. Drummondii*, the distribution of this is on this continent confined to the Canadian provinces. In his Catalogue of Canadian Plants (l.c.), John Macoun states that it never grows on mountain slopes, and that it is distributed from Quebec westward to British Columbia, and extends as far north as the shores of the Arctic sea, according to Richardson. Moreover, it occurs in eastern Siberia, along the Aldan river (Turczaninow). With regard to the Siberian plant Ledebour (Fl. Ross. l.c. Vol. 2, p. 21) makes the following statement: "Specimina fructifera, quae benevolentiae cl. Turcz. debeo, ab americanis a cl. Hooker mecum communicatis non differunt nisi laciniis calycinis paulo angustioribus et longioribus."

We have thus in the genus *Dryas* three species, the only ones of the genus, viz.: *D. octopetala* which is circumpolar-alpine, *D. integrifolia* which is arctic-alpine, and finally *D. Drummondii* which is only exceptionally arctic, and which furthermore does not seem to be alpine farther south.

The centre of distribution of *D. octopetala* and *D. integrifolia* may have been within the polar regions, from where they migrated towards the south during the glacial epoch. Of these the former became thus widely distributed in the mountains of both Worlds, except the Himalayas, while *D. integrifolia* did not extend beyond the mountains of this continent. *D. Drummondii*, on the other hand, evidently had its centre south of the arctic regions, in the Canadian Rockies evidently, and may have developed much later than the others. *D. octopetala* and *D. integrifolia*, especially the former, are still, as we know, represented on the higher mountains as remnants of a glacial flora. The limited occurrence in the arctic region shown by *D. integrifolia* well corresponds with its present distribution farther south on the American continent, but, as mentioned above, this species and *D. Drummondii* have extended their range in a western direction to the eastern part of northern Asia. But with regard to *D. octopetala*, the wide range which it occupies throughout the mountainous districts of both Worlds is seemingly in good accordance with a former, equally extensive distribution in the polar regions.

Another interesting distribution may be illustrated by the genus *Sieversia*, and although only one species, *S. glacialis*, was found by the expedition, it may be appropriate to give a general view of the distribution of the genus "in toto."

The following species occur on this continent: *S. glacialis* R. Br., *S. triflora* R. Br., *S. Rossii* R. Br., *S. calthifolia* Menz., and *S. radiata* (Michx.) Greene. Of these, *S. triflora* is not arctic, but extends from Labrador and Newfoundland to British Columbia, and follows the Rocky mountains south to Colorado

S. radiata grows in the Alleghany mountains, North Carolina, and a variety *Peckii* Gray has been recorded from alpine tops of the White mountains, New Hampshire; *S. Rossii* is common in the alpine region of the Rockies in Colorado, extending northward to the arctic shore and the archipelago, and westward to Alaska; *S. glacialis* is known only from the arctic seashore west of the Mackenzie river; *S. calthifolia* is known from the northwest coast, Unalaska and Sitka.

According to Ledebour, *S. glacialis* and *S. Rossii* occur in eastern Siberia, *S. calthifolia* in Kamtchatka. Beside these a fourth species is enumerated by Ledebour (Flora Ross. l.c.), *S. anemonoides* R. Br., also from Kamtchatka. Finally, there are two species in the Alps and Pyrenees, *S. montana* (L.) Spreng., and *S. reptans* (L.) Spreng., and one in the Himalayas, *S. elata* Royle (alt. 9,000-15,000 ft.).

We have thus before us a genus of quite an extensive geographical distribution, but disconnected and seemingly unexplainable.

None of the species are circumpolar; none have been reported from arctic Europe, and nevertheless, two species, one of which is very characteristic by its stoloniferous habit (*S. reptans*), inhabit the Alps and Pyrenees. On the Siberian north coast from 173° W. Long. to 68° E. Long. *S. glacialis* is the only species recorded so far (Kjellman, l.c.); the genus is absent from the Altai and Baikal mountains which otherwise harbour so many arctic species; in the northeastern corner of Asia, however, *S. Rossii*, *S. calthifolia*, and *S. anemonoides* are indigenous. But between these regions and the Himalayas no species has been recorded and, as mentioned above, only one occurs in these mountains.

On this continent, however, the distribution is fairly well connected. For even if *S. glacialis* and *S. calthifolia* are very rare on the northwest coast, and none of them crossing the Mackenzie river, we have in *S. Rossii* a species quite extensively distributed in the arctic region, including the islands of the archipelago, and extending south to the alpine summits of the Rockies; furthermore, *S. triflora* which is not arctic but widely distributed from the Atlantic to the Pacific slope and southwards to Colorado, following the Rocky mountains. Finally, the Alleghenies and the White mountains are the home of *S. radiata*. But in spite of this fair representation of the genus on this continent, none has been discovered in Greenland.

If now the question be asked where these species, or let us say the genus, originated, the answer cannot possibly be in the south, nor in the north alone. The South European elements did certainly not come from the north, since they are endemic to these mountains; they must have originated there, where, furthermore, they are associated with two near allies: *Geum* and *Dryas*.

With reference to the arctic species, *S. glacialis* and *S. Rossii*, these must have developed in the polar regions, and of these the latter, *S. Rossii*, did not altogether leave the south when the arctic flora returned for, as mentioned above, it is still in existence on the alpine summits of the Rockies, in Colorado for instance. *S. triflora* and *S. calthifolia* are evidently of younger origin, both, however, from a northern centre evidently located in Canada. Another centre of development must have been in the Appalachian mountains, so far as concerns *S. radiata*. Finally, with regard to *S. elata*, so widely secluded from the other species, this must have originated in the Himalayas.

Considering these data it seems to be characteristic of the southern element of the genus that so very few species have become developed, and that these are endemic to the southern mountains: *S. elata* to the Himalayas, *S. reptans* and *S. montana* to the Alps and Pyrenees and, finally, *S. radiata* to the Appalachian mountains. The reason may be that the centres are of a more recent date, and therefore entirely independent of each other. And it is a point of great importance, I believe, that these independently developed species nevertheless show the typical habit of true *Sieversia;* the only distinction appears in

S. reptans where stolons above ground are developed, but otherwise the habit is the same, and the structure of the style, so characteristic of the genus, is identical.

And, when a small genus like *Sieversia* has actually been produced at stations so remote from each other, but in the alpine regions, there seems to be a corresponding probability to suppose that the same species might also be produced independently from more than but a single centre, as long as the conditions are the same, or at least approximately so, in respect to climate and soil and in regard to association with allied types.

If it were within the scope of this report to include the geographical distribution of alpine species, several instances might be mentioned which would be strongly in favour of Schouw's hypothesis. However, I can not abstain from recording one, inasmuch as it is a Canadian plant. I think of the discovery of *Papaver pyrenaicum* L. in the Rocky mountains: South Kootenay pass, Sheep mountain, Waterton lake, besides that I found some specimens in the U. S. Nat. Herb. from Montana: Near Stanton lake, alt. 7,500 feet; these were labelled *P. nudicaule*. I might state at the same time that Mr. James M. Macoun sent the specimens to the British Museum in order to have my determination verified, and he was informed by the botanists of the said institution that the specimens proved the first record of the species on this continent.

It would certainly be too strange, I think, to explain the presence of this South European species in the Rocky mountains, as being in any way connected with some centre in the Pyrenees. The stations in both countries are alpine, and the association with allied types is about the same: *P. alpinum* L. and *P. nudicaule* L. Consequently, it seems probable that *P. pyrenaicum* originated from two centres: one in the Pyrenees and a second in the Rocky mountains.

Returning to the arctic species of the Rosaceae, the genus *Potentilla* is represented by seven species, two of which, *P. palustris* and *P. nivea*, are circumpolar; the others, with the exception of *P. fruticosa*, are principally arctic types. With respect to *P. palustris*, this species is nowhere abundant in the arctic region, and it is perhaps one of southern species which accompanied the arctic on their retreat, rather than having actually originated there. *P. nivea*, on the other hand, is undoubtedly of arctic origin owing to its very wide distribution and frequently abundant occurrence; its occurrence in the Alps, the Pyrenees, Caucasus, the Altai and Baikal mountains may be explained as it being a remnant of a post-glacial vegetation left over on these mountains. But concerning *P. pulchella*, *P. rubricaulis*, *P. Vahliana*, and *P. emarginata*, these appear to be arctic American types, some having extended eastward to Greenland. It is a strange fact that *P. pulchella* occurs in Spitzbergen although it is entirely absent from arctic Europe; perhaps a former more extensive distribution may have been interrupted.

The circumpolar *Rubus Chamaemorus* is not uncommon in Central Europe but, nevertheless, it is not represented in the Alps of Switzerland nor in the Pyrenees, and it is also absent from the Rocky mountains; in Greenland it is very rare and has only been found between 61° and 64° N. L. With regard to the occurrence of the species in Canada, John Macoun states that it is especially abundant in the north and that, when found at its southern limit, it always occurs in cold peat bogs; as far south as 53° N. L. it has been found in peat bogs at the base of Porcupine mountain in Manitoba. King William island is the only station known from the American archipelago. It is interesting to notice that in Canada it is often accompanied by *Rubus arcticus* L., as is the case also with the Scandinavian plant.

Evidently the habitat "peat bog," where the species thrives at its best, explains its absence from the southern mountains, and the centre of its distribution may be sought in the polar regions, even though it seldom becomes sufficiently advanced to produce mature fruit in these regions.

Of *Rosa acicularis* Lindl. a single specimen, a small branch with a well preserved flower, was collected by Rev. I. O. Stringer at the Mackenzie river delta; the species has also been collected on the American coast of Bering strait, and it is recorded by John Macoun from Fort Simpson on the Mackenzie river, Fort Yukon, the Kuskokoin valley, and St. Michael's island, Alaska, the specimens having been collected by Mr. Watson. The species is known, furthermore, from Siberia, viz.: Davuria and Kamtchatka.

Of the Papilionaceae thirteen species were collected by the expedition, exactly one-third of the species known so far to have extended to the arctic region. From Table 1 it will be noticed that three of these are circumpolar, viz.: *Astragalus alpinus*, *Phaca frigida*, and *Oxytropis campestris*. However, their distribution is so extremely scattered within the arctic region that they hardly may be defined as circumpolar; for instance, on the north coast of Siberia, *Astragalus* has only been reported from Dickson harbour (80° 58′ E. Long.), *Phaca* only from Preobrascheni island (113° 10′ E. Long.), and *Oxytropis* only from Dickson harbour. And the other species known from the Siberian coast are just as rare, for instance: *Oxytropis Mertensiana* only at the mouth of the river Olenek (120° E. Long.), *O. nigrescens* only at the mouth of the river Kolyma (161° E. Long.), besides Pitlekaj (175° 24′ W. Long.); finally, *Hedysarum obscurum* L. has only been reported from Pitlekaj, and *Phaca alpina* Wulf. (non Ledebour) was discovered by Sujef on the shore of the Kara sea.

To emphasize fully the arctic distribution of these Papilionaceae, Table 5, showing the distribution of all the species of this family within the arctic region, is inserted. It will be seen from this table that, so far, only 39 species have been collected in this region. They represent 12 genera, with 13 species belonging to *Oxytropis*, 7 to *Astragalus*, 4 to *Vicia*, 3 to *Hedysarum;* the other genera contain only one or two species.

TABLE 5.

Geographical distribution of Papilionaceae in the arctic regions of America, Europe, and Asia.

	North coast of America	Islands of the arctic American archipelago	Arctic west coast of Alaska	Greenland	Arctic Scandinavia	Arctic Russia	Nova Zembla	North coast of Siberia	Asiatic coast of Bering strait
Anthyllis Vulneraria L.					•	•			
Astragalus aboriginorum Richards	•	•							
A. alpinus L.	•	•	•		•	•	•	•	•
A. arcticus Bunge						•		•	
A. chorinensis Bunge									•
A. hypoglottis L. ?			•						
A. oroboides Hornem.						•			
A. polaris Benth.			•						
Ervum hirsutum L.				•		•			
Hedysarum alpinum L.	•	•	•						
H. Mackenzii Richards	•	•	•					•	
H. obscurum L.						•	•	•	•
Lathyrus maritimus (L.) Bigel	•		•	•	•	•			

TABLE 5.

Geographical distribution of Papilionaceae in the arctic regions of America, Europe, and Asia.

	North coast of America	Islands of the arctic American archipelago	Arctic west coast of Alaska	Greenland	Arctic Scandinavia	Arctic Russia	Nova Zembla	North coast of Siberia	West coast of Bering strait
L. pratensis L.									
Lupinus arcticus Wats.									
L. nootkatensis Donn.	•		•						
Medicago lupulina L.				•					
Orobus vernus DC.									
Oxytropis arctica R. Br.		•	•						
O. arctobia Bge.	•	•							
O. Bellii (Britt.) Sheld.		•							
O. campestris DC.	•	•	•		•				
O. foliolosa Hook.	•								
O. Maydelliana Trautv.									
O. Mertensiana Turcz.									
O. Middendorffii Trautv.									
O. lapponica Gaud.					•	•			
O. nigrescens (Pall.) Fisch.	•	•	•						
O. Rouldi Ostf.	•								
Oxytropis Schmidtii Meinsh.									
O. strobilacea Bunge									
Phaca alpina Wulf. (non Ledeb.)						•			
P. frigida L.	•		•		•	•	•		
Trifolium pratense L.						•			
T. repens L.						•			
Vicia Cracca L.				•	•	•			
V. gigantea Hook.				•	•	•			
V. sepium L.			•						
V. sylvatica L.						•			

However, several of these are introduced weeds, for instance, *Ervum*, *Medicago*, *Trifolium*, and *Vicia* in Greenland, where *Lathyrus maritimus* is the only indigenous member of the family. The remarkably scant representation of the family in the arctic region may indicate that the Papilionaceae are not well adapted to the severity of that climate. With regard to the circumpolar *Astragalus alpinus*, *Phaca frigida*, and *Oxytropis campestris*, these have undoubtedly had their original centre in the polar regions; they are, together with *Hedysarum obscurum*, *Oxytropis lapponica*, and *Astragalus oroboides*, the only ones that have reached the Alps and the Pyrenees, and it is interesting to notice that while *Hedysarum* does occur in the arctic region of Europe and Asia, *Oxytropis lapponica* and *Astragalus oroboides* are arctic in Scandinavia and Russia alone;

furthermore, that *Astragalus alpinus* and *Phaca frigida* have also reached the Altai, the Baikal, and even the Himalaya mountains; but on this continent these two species do not accompany each other for *Phaca* stops at the arctic circle while *Astragalus alpinus* extends as far south as the Rocky mountains in Colorado. *Oxytropis campestris*, on the other hand, while distributed throughout Canada from Labrador to Kotzebue sound, Alaska, does not follow the Rocky mountains farther south. It would thus appear as if *Astragalus alpinus*, *Phaca frigida*, *Oxytropis campestris*, and *Hedysarum obscurum* originated in the polar regions, and that the Rocky mountains, the Alps, the Pyrenees, the Altai, and Baikal mountains where the species are still in existence, were reached during the glacial epoch. The arctic distribution of *Hedysarum obscurum* corresponds well with its occurrence further south, viz.: the European Alps, Ural mountains, Altai and Baikal mountains, and eastern Siberia between Aldan and Okhotsk.

Among the other species are some genuine American types, viz.: *Lupinus*, *Astragalus polaris*, *A. aboriginorum*, *Hedysarum alpinum*, *H. Mackenzii*, *Oxytropis arctobia*, *O. arctica*, *O. Bellii*, *O. foliolosa*, *O. Roaldi*, and *Vicia gigantea*, some of which are confined to the arctic region of this continent. With regard to *Oxytropis nigrescens* and *Hedysarum Mackenzii*, being natives of the north coast of this continent as well as of Siberia, these may be looked upon as evidently representing former circumpolar species with a distribution considerably reduced during the glacial epoch.

A Siberian element is represented by *Astragalus chorinensis*, *Oxytropis Maydelliana* *O. Middendorffii*, *O. Mertensiana*, *O. Schmidtii*, and *O. strobilacea*. With the only exception of *O. strobilacea*, which has also been collected in the Altai mountains, southwest Mongolia, and western China, the others are confined to the arctic region of Siberia, between 69° and 76° N. Lat., from the Asiatic coast of Bering strait to the river Jenisei.

Then with regard to Europe, its contingent to the arctic flora is relatively small, and *Astragalus arcticus* is the only species restricted to the arctic zone; it is also a native of arctic Siberia. The other plants are *Anthyllis*, *Astragalus oroboides*, *Lathyrus pratensis*, *Orobus*, *Oxytropis lapponica*, *Trifolium*, *Vicia Cracca*, and *V. sylvatica*, all of which are much better represented farther south; with the exception of *Astragalus* and *Oxytropis* they are all lowland plants.

Lathyrus maritimus, distributed as a seashore plant throughout the northern hemisphere, has reached the arctic regions in many places and is, as mentioned above, the only member of the Papilionaceae that has reached Greenland. According to its habitat, and being at present much more abundant in the south than in the north, it is evidently a post-glacial introduction in the arctic regions.

Of the arctic representatives of the Papilionaceae *Astragalus* and *Oxytropis* are of special interest. We have in the former two species endemic to this continent, namely: *A. aboriginorum* and *A. polaris;* endemic to Asia is *A. chorinensis*, and common to Siberia and Russia is *A. arcticus*. Among the thirteen arctic species of *Oxytropis* five are endemic to this continent, viz.: *O. arctica*, *O. arctobia*, *O. Bellii*, *O. foliolosa*, and *O. Roaldi;* endemic to Siberia are *O. Maydelliana*, *O. Mertensiana*, *O. Schmidtii*, and *O. strobilacea*, while *O. nigrescens* is common to Siberia and this continent. As mentioned above, *O. strobilacea* is widely distributed farther south in Siberia, Mongolia, etc., and *A. aboriginorum* is very frequent on this continent in the Canadian west, and northern United States, the prairie region for instance. In other words, the arctic regions of Siberia and America represent some quite important centres of distribution of these genera, and especially of *Oxytropis*. The species must have originated in these regions, and their present very scattered distribution may indicate that they have been partly exterminated, the localities having become disconnected during the glacial

epoch. It seems strange that no species of *Trifolium* has reached the polar regions, nor seemingly developed there, although the high alpine section *Lupinaster* might be well adapted to these regions. I think especially of the American *Trifolium nanum* Torr., *T. dasyphyllum* T. et G., and *T. Parryi* Gr., the South European *T. alpinum* L., and the Siberian *T. Lupinaster*. *T. alpinum* is a native of the Pyrenees, the Alps of Switzerland, and the South German mountains; *T. Lupinaster* is widely distributed in northern Siberia, principally in the mountains: Ural, Altai, Baikal, and Davuria. The American species, on the other hand, are endemic to the Rocky mountains. We have thus in the genus *Trifolium* a section which has developed in mountains very far apart and which has produced some few species of exactly the same habit, similar to the case in the genus *Sieversia*.

Recorded from all the regions marked on the geographical Table I. with the only exception of the Himalayas, *Empetrum nigrum* is thus circumpolar, and widely distributed farther south throughout the northern hemisphere; moreover, it follows the Andes in South America to the antarctic region, but is absent from the other parts of the southern hemisphere. On the west coast of Greenland *Empetrum* extends as far north as 7°° 18′ N. L., Foulke fjord (Hart); on the east coast it has been found at 74° N. L., Clavering island (Dusén), and in Spitzbergen at about 78° 30′ N. L. (Nathorst). It deserves mention that Dusén (l.c.) found it with flowers, partly hermaphrodite and partly dioecious (pistillate), and also with fruits from the previous year at Cape Parry, about 72° 30′ N. L. In Spitzbergen it was collected in full bloom in the latter part of July by Gunnar Andersson and Hesselman (l.c.), and the flowers were partly hermaphrodite, partly pistillate; however, some fruits from the year previous, still attached to the branches, were withered and contained no stones, thus the authors conclude that the plant is sterile in Spitzbergen. As Nathorst and Gunnar Andersson succeeded in detecting several well developed stones of the fruit in the Mytilus strata on this island, it seems probable that deterioration in climate since the deposition of the said strata caused the present sterility of the species.

The two species of *Epilobium*, *E. angustifolium* L., and *E. latifolium* L., collected on the arctic shore, are both of the section *Chamaenerion*; two others, *E. Dodonaei* Vill., and *E. Fleischeri* Hochst., are natives of the Alps in Switzerland, the former also of the Pyrenees and Caucasus. While *E. angustifolium* and *E. latifolium* accompany each other in the arctic region, the former shows the widest distribution farther south; they both, however, have reached the Himalayas, the Altai and Baikal mountains, and the Rocky mountains as far south as Colorado; but only the former occurs also in the European Alps, the Pyrenees, Caucasus, and arctic Scandinavia. In the United States *E. angustifolium* is very common in low grounds, in clearings and newly burned lands, from the Atlantic to the Pacific; in Canada, it extends from Labrador west to the Pacific and Alaska, and north to the arctic shore. *E. latifolium* is in the United States confined to the Rocky mountains and N. E. Oregon, while in Canada it is very widely distributed from east to west, reaching the shores and islands of the Arctic sea in every degree of longitude.

With regard to the distribution in East Greenland, *E. latifolium* was found by Dusén at 74° 30′ N. L., while in West Greenland it reaches 78° 18′ N. L., Foulke fjord. *E. angustifolium*, on the other hand, is less frequent, occurring on the west coast between 60° and 72° N.L., on the east coast between 60° and 63° 30′ N. L. But characteristic of both is the fact that several varieties have been observed, especially on the west coast, however.

Considering the fact that the seeds are remarkably well fitted for dissemination by the wind, it seems natural that the species have become distributed so very widely. But it seems impossible to decide the location of their geographical centre. They both are circumpolar and, as far as concerns *E. latifolium*, it may have originated in the north, in the polar regions, or close to them. Otherwise

with respect to the other species of which the habitat, as mentioned above, speaks in favour of a centre farther south. Moreover, the fact that it is associated with two closely allied species in southern Europe, seems to indicate a southern location of the centre of distribution, in Europe rather than in Asia or America.

In outlining the geographical distribution of *Hippuris* (see Table 1), I might just as well quote from Bentham and Hooker's great work "Genera plantarum," in which it is given as follows: "Species 1 vel. 2, aquarum temperatarum et frigidarum Europae, Asiae mediae et boralis, et Americae borealis et Antarcticae incolae." And to these data may be added that it is circumpolar. *Hippuris* was found by Kjellman at Pitlekaj on the north coast of Siberia, Lat. 67° 5′; in Greenland the typical plant is rare and confined to the southernmost part at about 60° N. L.; the variety *maritima* Hartm., on the other hand, is known from the west coast of Greenland between 60° and 70° N. L., and on the east coast it has been reported by Dusén from Hurry inlet (71° N. L.), and by Hartz from Scoresby sound, at the same latitude. We have thus in *Hippuris* an excellent illustration of the remarkably wide range exhibited by many freshwater and even marsh species. Several other examples might be recorded but I shall confine myself to mention a few, for instance: *Hydrilla*, of which the only species, a freshwater plant, is known from tropical Asia and Australia; *Vallisneria*, common to the temperate and warmer regions of both Worlds; *Hydrocharis*, common to Europe and Asia; *Enhalus*, from the seashore of Ceylon to the seashore of Australia; *Ranunculus natans* C. A. Mey., from Colorado (Twin lakes near Leadville), known also from Siberia (Altai and Baikal); finally, *Caltha natans* Pall., from eastern Siberia, Baikal mountains, Jenisei, furthermore on this continent: Minnesota, and, in the Northwest Territory: Peace river tributaries near Fort St. John, Methy portage, at about 57° N. L. How these and many other aquatic plants were dispersed so as to acquire such enormous distribution has been explained by Darwin (Origin of Species), the means of dispersal being notably wading birds. However, as has been mentioned in the preceding pages, migratory birds may well be capable of dispersing seeds or shoots of aquatic plants from one point to another, thus covering areas of no small extent even during a single season, but from what we have learned about these birds, when migrating, in the stricter sense of the word, dispersal, from one continent to another, does not seem probable.

Bupleurum americanum C. et R. is credited to the American coast of Bering strait where it was first found by Chamisso and Eschscholtz "ad promontorium Espenberg," furthermore, to Alberta, Montana, Idaho, and Wyoming; according to Macoun's Catalogue (l.c.) it has been collected at Fort Selkirk, Yukon river, at the foothills of the Rocky mountains (Lat. 49°), and east of the Mackenzie river (Richardson). Ledebour (Flora Rossica) considered the species to be identical with the South European *B. ranunculoides* L., and so did Hooker (Fl. Bor. Am.).

Meanwhile he Montana plant has been described as *B. purpureum* Blankinship, but the characterization of this as well as of *B. americanum* is not very clear as compared with any of the Old World species, not even with *B. ranunculoides* L.

The genus contains about 60 well marked species but 90 have been described, according to Bentham and Hooker. There are about 8 perennial species, among which *B. ranunculoides* inhabits the Alps of Switzerland, about 16 the Pyrenees; and several are also reported from temperate Asia and the tropical mountains.

B. ranunculoides has not, so far, been recorded from northern Asia, while Ledebour enumerates several others from Altai, Baikal, and Davuria. It would seem rather singular if *B. ranunculoides* really occurred on this continent, since it is absent from Asia. And it would seem just as strange if the genus had

developed on our arctic coast and in the mountains with a species distinct from all those recorded from the Old World, since the genus has no immediate allies on our continent. None of the Old World species have been recorded from the arctic region and, with respect to the American representative of the genus, it seems more probable that it actually represents one of the East Siberian species, or at least, perhaps, a form of these. The stations on the Alaskan coast might indicate that the species came from Siberia, and its occurrence on the northern coast as well as in the Rocky mountains would be readily intelligible. Thus, considered from a geographical point of view, and also in view of the absence of allied species and even of genera, it would appear as if the North American plant were to be more naturally understood as identical with one of the Old World species, or perhaps as a form of one of these.

Only one species of *Pyrola* was collected by the expedition, namely *P. grandiflora*, but on the islands of the Arctic archipelago it is accompanied by *P. minor*. The geographical distribution of *P. grandiflora* points especially to the arctic region of our continent as having been its centre, and it will be remembered that the species is very frequent in Greenland where it extends as far north as Lat. 78° on the west coast and Lat. 73° on the east coast (Dusén). Nevertheless, it is also quite widely distributed farther south, in Canada, for instance, "Labrador, Mackenzie River," and in Asia it has even reached the Altai mountains. And in the Altai mountains the species is accompanied by *P. rotundifolia*, a very near ally, furthermore by *P. minor*, *P. secunda*, *Moneses uniflora*, and even by *Chimaphila umbellata*.

I mention the occurrence of these Pyrolaceae in the Altai mountains since we have in these mountains one of the most important centres of distribution of the glacial flora, the arctic and the alpine, as demonstrated by Nathorst. As stated above, this author has called attention to the fact that at the present time the Altai mountains harbour a considerable element of the arctic flora, among which many rare species, as for instance *Pleuropogon Sabinii* R. Br., formerly considered to represent one of the very few species endemic to the polar region; t was not until the year 1898 that it was discovered in the Altai mountains.[1]

TABLE 6.

Geographical distribution of the Pyrolaceae, principally in the northern regions of both Worlds.

	West coast of Alaska	North coast of America inc. Is. of archipelago	Greenland	Arctic Scandinavia	Arctic Russia	Eastern Siberia	Terra Tschuktchorum	Kamtchatka	Altai and Baikal mts.	Caucasus	South Russia	Alps of Switzerland	Pyrenees	Iceland	Canada south of arctic circle	Atlantic United States	Central United States	Pacific United States
Chimaphila umbellata (L.) Nutt.	...	...	..	..	..	..	..	..	•	..	..	•	..	..	..	•	..	..
Chimaphila umbellata v. *cisatlantica* Blake	...	...	...	..	..	..	..	..	..	..	..	..	..	..	•	•	•	..
Chimaphila umbellata v. *occidentalis* Blake	...	...	...	..	..	..	..	..	..	..	..	..	..	..	..	..	•	•
Chimaphila umbellata v. *mexicana* DC.	...	...	...	..	..	..	..	..	..	..	..	..	..	..	•	..	•	•
Chimaphila umbellata v. *acuta* Blake	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Chimaphila umbellata v. *Menziesii* (R. Br.) Sprg	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	•	..
	..	..	..	..	..	..	..	..	..	..	..	..	..	..	-	..	..	•

[1] "In alpinis montium altaicorum orientalium ad trajectum (2,800 m.) inter fl. Dshumala et Ak-koll in locis humidis," according to label of specimen.

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	West coast of Alaska	North coast of America inc. Is. of archipelago	Greenland	Arctic Scandinavia	Arctic Russia	Eastern Siberia	Terra Tschuktchorum	Kamtchatka	Altai and Baikal mts.	Caucasus	South Russia	Alps of Switzerland	Pyrenees	Iceland	Canada south of arctic circle	Atlantic United States	Central United States	Pacific United States
Chimaphila maculata (L.) Pursh															*	*	*	
Moneses uniflora (L.) Gr.	*			*	*	*			*		*	*	*		*	*	*	*
Pyrola minor L.	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*
Pyrola minor v. *brevis* Lge.			*															
Pyrola secunda L.	*			*	*	*			*	*	*	*	*	*	*	*	*	*
Pyrola secunda v. *obtusata* Turcz			*				*								*	*	*	
Pyrola secunda v. *pumila* Ch. et Sch.	*					*			*						*	*	*	
Pyrola secunda v. *dispersa* Norm.				*														
Pyrola chlorantha Sw.	*			*								*	*		*	*	*	*
Pyrola chlorantha v. *occidentalis* R. Br.	*														*			
Pyrola elliptica Nutt.															*	*	*	
Pyrola media Sw.				*						*		*		*				
Pyrola rotundifolia L.	*			*	*	*	*	*	*	*	*	*	*		*	*	*	*
Pyrola rotundifolia v. *incarnata* DC.	*														*	*		
Pyrola rotundifolia v. *asarifolia* Hook.	*														*	*		
Pyrola rotundifolia v. *uliginosa* Gr.	*														*	*	*	*
Pyrola rotundifolia v. *bracteata* Gr.															*			*
Pyrola rotundifolia v. *arenaria* Koch.			*	*											*			
Pyrola rotundifolia v. *pumila* Hornem.				*		*												
Pyrola rotundifolia v. *bracteosa* [illegible] m				*														
Pyrola grandiflora Rad.	*	*	*				*		*						*			
Pyrola grandiflora v. *lutescens* Lge.			*															
Pyrola picta Smith	*														*		*	*
Pyrola aphylla Smith	*														*			*
Pyrola chimaphiloides Greene															*			

With regard to the Pyrolaceae, several of the other species have also been recorded from the arctic region, notably from Greenland, arctic Scandinavia, and arctic Russia, but none from Spitzbergen nor from arctic Siberia; in other words, the genera do not contain any circumpolar species. While studying the geographical distribution of some of the species, notably the arctic ones, I have noticed several points which might be useful to the location of their centres, and for this reason I have thought it appropriate to insert a table (Table 6) showing their distribution, principally in the northern regions of both Worlds. No species has, so far, been reported from the southern hemisphere. *Pyrola* is credited to the northern and central parts of both Worlds, including Mexico; the monotypic *Moneses* to northern and Central Europe, Asia, including Japan, and the northern and middle parts of this continent; *Chimaphila* shows the same distribution, but including Mexico, Santo Domingo, and Corea.

Besides the species I have enumerated several varieties in order to illustrate the development of the species in the various countries. With regard to *Chimaphila*, *C. maculata* and *C. Menziesii* are confined to this continent, the latter being mainly a western type, the former an eastern. *C. umbellata*, on the other hand, extends from the Atlantic to the Pacific slope; moreover, it occurs in Europe from the southern parts of Scandinavia, through Denmark and Germany to Switzerland (Zürich); it is not known from England, Scotland, or Ireland, according to Babington.[1] In Asia *C. umbellata* is known from Manchuria, Altai and Baikal mountains.

Four varieties have been recognized of *C. umbellata*, namely: *cisatlantica* Blake from Quebec, New Brunswick, Prince Edward Island, and Nova Scotia, to western Ontario and Minnesota, southward to Virginia; *occidentalis* (Rydb.) Blake from British Columbia to Colorado, and the mountains of north-central California; *mexicana* DC. from southern Mexico; *acuta* (Rydb.) Blake from New Mexico and Arizona. These varieties have been very carefully described and discussed by Dr. S. F. Blake[2] who, furthermore, has segregated the Santo Domingo representative of *C. umbellata* as *C. domingensis* Blake,[3] endemic to this island.

According to Maximowicz (Flor. Amur. l.c.) a fifth species, *C. japonica* Miq. (*C. astyla* Maxim.), is a native of Japan and Manchuria.

C. umbellata and *C. maculata* are lowland plants, sylvan types, which nowhere enter the arctic region; they evidently originated on the Atlantic slope, but the occurrence of the former on the Asiatic coast of Bering strait, in Manchuria and Altai, and also in Central Europe, may indicate a former, much wider distribution, but disconnected at present. The fact that the genus is best represented on this continent, with three closely allied species, seems to be in favour of locating the centre of the genus on this continent.

A much wider distribution is exhibited by *Moneses* which furthermore has been recorded from Manchuria (Maximowicz l.c.). It enters the arctic region in Scandinavia and Russia but nowhere in Siberia, nor on this continent; in Europe it extends as far south as the Alps and Pyrenees but is not alpine, and on this continent to Colorado. The occurrence of *Moneses* in arctic Europe may indicate that it is one of the temperate plants which accompanied the arctic on their retreat to the north, and it seems most natural, I think, to attribute a southern centre to the species, or let us say genus, since it is monotypic. But where in the south is impossible to decide.

In both Worlds it inhabits shady or mossy woods, especially coniferous, and it is, more or less, associated with the same species of *Pyrola*. It is remarkably constant in its habit, and no variety has, as far as I know, been reported. Although a native of the Altai and Baikal mountains, *Moneses* has not become

[1] Manual of British Botany. 7th ed. London, 1874.
[2] Rhodora, Vol. 19, p. 237. Boston, 1917.
[3] Journ. Botany LII, p. 169. London, 1914.

distributed farther north, but the genus, nevertheless, has reached the eastern part of Siberia and Manchuria from where it extends to Alaska, until it reaches the northern and middle regions of this continent where, from the Atlantic to the Pacific, the genus exhibits its widest distribution.

It would seem quite natural to consider the wooded belts of the middle parts of this continent to represent a geographical centre of *Moneses;* possibly the genus migrated from there to eastern Siberia, Manchuria, and the Altai mountains, rather than vice versa.

Absent from arctic Siberia but recorded from all the other districts enumerated on the table (Table 6), *Pyrola minor* thus shows the widest distribution of all the members of Pyrolaceae. On this continent the habitat is given as "cold woods, Labrador, White Mountains of New Hampshire, Rocky Mountains from New Mexico and northward to the Barren country from Lat. 64° to the Arctic Islands." Nowhere is it alpine, however, and in the temperate parts of both Worlds it is associated with the same species of *Pyrola*, and, not infrequently, also with *Moneses.*

It seems barely possible to suppose that the species was formerly represented in arctic Siberia, thus having been a member of the circumpolar flora, even if it is known to occur very near Lat. 70° on the west coast of Greenland (Hartz), and on Melville peninsula (Parry). It is, however, a rare plant in the arctic region and, being decidedly a sylvan type, the geographical centre must have been located south of the polar regions, in the wooded belts of the Old World, presumably, since it is much more abundant there than on this continent, and more evenly distributed from north to south. Like *Moneses* it is very constant in habit, only one variety having been recorded, var. *brevis* Lge. from Greenland.

An almost corresponding distribution is shown by *P. secunda*, with exception of its absence from arctic America and Kamtchatka; in Greenland the typical plant does not occur, but is replaced by the variety *obtusata* Turcz.; this variety is also recorded from Terra Tschuktchorum, from Canada, the Atlantic and Central United States. Like the preceding species, *P. secunda* is a woodland type and is not known to be alpine. Besides the variety *obtusata*, two others have been described, viz.: *pumila* Cham. et Schl., and *dispersiflora* Norm.; of these the former is distributed from Labrador to Alaska; it follows the Rockies south to Colorado, and has been recorded from eastern Siberia and Altai. The var. *dispersiflora* Norm. is known only from arctic Scandinavia. Considering the relatively wide distribution of the typical plant on this continent in the north as well as in the south, extending to California, Colorado, and Maryland, and in view of the development of two characteristic varieties, it appears as if some important centre must have existed on this continent, presumably in the wooded belts of the northern part. With regard to the Siberian distribution of *P. secunda*, we have seen that this extends from Terra Tschuktchorum, eastern Siberia to Altai, and, furthermore, Maximowicz has recorded it from East Manchuria. But the absence of the species from the boreal regions of Siberia, except in the northeastern corner, makes me believe that the Asiatic element of the species has really originated on the American continent.

Two important centres of distribution must undoubtedly be attributed to *P. chlorantha*, as shown on the accompanying table (Table 6). On this continent the distribution extends from Newfoundland, Labrador, and the Maritime Provinces westward to northern British Columbia and Alaska, south to California, Colorado, and Maryland. In Europe *P. chlorantha* has reached the arctic zone in Finmark; it is quite generally distributed through the European continent, going as far south as the Alps, the Pyrenees, and Kasan in Russia. But so far, the species has not been observed in Asia, and it is thus the more interesting to notice that an analogous species does exist in eastern Manchuria, namely *P. renifolia* Maxim. It would be difficult to combine the European distribution

with the American, except by means of a former wider distribution in the polar regions, which the species has reached, though only in Finmark; and judging from the fact that the species is absent from Greenland and the entire arctic coast of our continent, besides from Siberia, it would appear as if the species had a dual origin, from one centre in Europe and from another one in America, inasmuch as the environment is identical and it is associated with the same species of the genus, with *Moneses*, and with *Chimaphila*. The occurrence of some of the species of *Pyrola*, *Moneses*, and *Chimaphila* in eastern Manchuria, and extending from there to Japan, and among these being several endemic species, seems to indicate an important centre of the genus on the eastern coast of Asia.

The widely distributed *P. rotundifolia* reaches the arctic region only in Finmark and Russia since, according to Ledebour, the species has not been recorded from arctic Siberia; it occurs, however, in Terra Tschuktchorum. The distribution agrees remarkably well with that of *P. secunda* but, as may be seen from the table (Table 6), *P. rotundifolia* is quite a variable plant, seven characteristic varieties having been described; thus it appears as if the species is exceptionally well established in various parts of the northern countries, rather than in the southern. It is totally absent from Greenland and the arctic coast of the American continent but is there replaced by a close ally, *P. grandiflora*, which by several authors has been considered as a mere variety of *P. rotundifolia*. It does not seem improbable that *P. grandiflora* has developed from *P. rotundifolia* in the arctic environment, but in any case the former is unquestionably of American origin as stated above, even though it has reached the northeastern corner of Asia and the Altai mountains.

With respect to the typical *P. rotundifolia*, its habitat is somewhat peculiar since it may thrive just as well in Sphagnum bogs as in shady woods, notably coniferous. The [illegible]ems to be more typically developed on the European continent, besides in Eng[illegible]nd and Scotland, than really in North America where, however, it is accompanied by four varieties, endemic to this continent, and the variety *arenaria* (Hudson bay), known also from Greenland, Finmark, and south to Germany. The prevalence of the varieties on this continent may indicate an American centre of distribution of the species and at the same time the gradual disappearance of the type. A similar case is exhibited by the occurrence of the species in arctic Norway, where three varieties: *arenaria*, *pumila*, and *bracteosa* have been observed, and of these the variety *pumila* has also been collected in eastern Siberia. In other words, we have in the *P. rotundifolia*-alliance a series of types, some being characteristic of arctic Europe, others of the American continent south of the arctic circle, and one, *P. grandiflora*, especially characteristic of arctic America and Greenland. And it is quite interesting to notice that of these types the arctic *P. grandiflora* has also become distributed to Terra Tschuktchorum and Altai.

The remaining species: *P. elliptica*, *P. media*, *P. picta*, *P. chimaphiloides*, and *P. aphylla*, are mostly of a somewhat restricted occurrence. However, the distribution of *P. elliptica* comprises Newfoundland to British Columbia, and through the northern Atlantic states to the mountains of New Mexico. The species thus represents one of the members from the American centre of the genus; although absent from the northeastern corner of Asia, the species, nevertheless, has extended to Japan. *P. media* is a genuine European type, which has reached the arctic region of Norway, besides Iceland, together with *P. minor* and *P. secunda;* toward the south it has become distributed to the Alps of Switzerland and Caucasus. *Pyrola picta* and *P. aphylla*, on the other hand, are mainly western types, especially the latter; finally, *P. chimaphiloides* is known so far only from British Columbia.

In connection with these geographical notes may be mentioned that *Pyrola aphylla* is only apparently "aphyllous"; it develops, as a matter of fact, two kinds of aerial shoots, viz.: some that are terminal and bear a small rosette of green leaves preceding the inflorescence, and others which are lateral and develop

an inflorescence but no green leaves. From a paper which I have published some years ago,[1] it will be seen that this species is one of the very few plants that produce root-shoots, and at the same time is stoloniferous. Root-shoots, however, are known from some of the other Pyrolaceae viz.: *Moneses uniflora*, *Pyrola secunda*, and *P. chlorantha*,[2] to which may be added *P. picta*, *Chimaphila umbellata*, and *C. maculata*.

Among the Ericaceae, *Ledum*, *Rhododendron*, *Loiseleuria*, *Cassiope*, and *Arctostaphylos* show almost exactly the same distribution in the polar regions, with the exception of *Rhododendron* being absent from arctic Siberia, and *Cassiope* being a member of the flora of Spitzbergen. *Kalmia*, on the other hand, is confined to the American continent. We have thus four circumpolar species represented by this family. With respect to their distribution farther south, we see from Table 1 that *Loiseleuria* and *Arctostaphylos* are the only ones which extend as far south as the Alps and the Pyrenees, and that *Ledum* is the only one which occurs in the Altai mountains; none have been recorded from Caucasus and none from the Himalayas. With regard to their occurrence in the Rocky mountains, *Arctostaphylos*, *Cassiope*, and *Rhododendron* have been found in the northern range of these mountains while *Kalmia* extends down to Colorado, and down the Sierra Nevada to California.

Furthermore may be mentioned that *Arctostaphylos alpina* is in Greenland distributed as far north as Lat. 70° on the west coast, and 73° 50′ on the east coast (Dusén); that *Cassiope tetragona* extends to Lat. 79° on the west coast, and 77° on the east coast, besides, as stated above, that it occurs also in Spitzbergen; *Loiseleuria* does not extend farther north than Lat. 61° on the east coast of Greenland while on the west coast it extends to Lat. 74° 18′; *Rhododendron*, on the other hand, reaches the 74th latitude on both coasts; the variety *procumbens* of *Ledum palustre* reaches Lat. 74° in Greenland. This far-northern distribution may indicate that we have some truly arctic types represented by these species, and being besides circumpolar, except *Rhododendron*, they originated undoubtedly in these regions.

Otherwise with *Kalmia polifolia* (*K. glauca* Ait.) which is more widely distributed much farther south, to Pennsylvania, etc., and of which the forma "*microphylla*" is the only one represented in the alpine and arctic regions. Thus *Kalmia* is beyond doubt a southern type, with its centre located in the temperate zone of this continent where it is more or less associated with several other species of the genus.

While thus the arctic, circumpolar members of the Ericaceae occur with their typical habit at these high-northern latitudes, the Vacciniaceae *V. uliginosum* and *V. Vitis-Idaea* appear only as much reduced forms of dwarfed stature and with very small leaves; consequently they may not be regarded as arctic types but only as members of the southern flora which accompanied the arctic on the retreat to the north. *V. caesmitosum* is also a decidedly southern type and mostly an alpine one, endemic to this continent.

A very scattered distribution is exhibited by the Primulaceae. Although a distinctly American genus, *Dodecatheon* has reached the northeastern corner of Asia, "Terra Tschuktchorum," but only the species *frigidum*, which by several authors is considered a variety of the Atlantic *D. Meadia* L.; the other species are mainly Californian.

With respect to *Primula*, *P. borealis* is a native of arctic America but has also reached the Asiatic coast of Bering strait; *P. stricta* is quite extensively distributed toward east, namely: Greenland, Scandinavia, Russia, and Nova Zembla, but is absent from the southern mountains. Finally, *P. sibirica* is known also from Finmark, arctic Siberia, and Altai.

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[1] *Pyrola aphylla*. Bot. Gazette, Vol. XXV. Chicago, 1898.

[2] Irmisch, Th. Bemerkungen ueber einige Pflanzen der deutschen Flora. Flora. Vol. 38. Regensburg, 1855, p. 628.

The fact that the genus *Primula* is not a northern but a southern type, best represented in the mountains, notably in the alpine region of temperate Europe and Asia, seems to indicate that the few arctic representatives of the genus are remnants of a glacial flora, now partly exterminated, or at least disconnected.

Of the arctic Primulaceae the genus *Androsace* is the most widely distributed. *A. Chamaejasme* is almost circumpolar, being absent only from Finmark, Spitzbergen, and Greenland; with regard to *A. septentrionalis*, this occurs in Finmark but is absent from arctic Siberia. Farther south these species have also been recorded from the Alps of Switzerland, from Caucasus and Altai, and from the Rocky mountains from Alberta to Colorado.

However, the genus is relatively poorly represented on this continent, by four species according to Gray, but more recently some three or four more have been described and generally accepted. In the Alps of Switzerland, however, the genus culminates with thirteen species; furthermore, seven species are known from Caucasus, eight from the Altai and Baikal mountains, eight from eastern Siberia, five from Ural, etc. It would thus appear as if the actual centre of the genus must be sought in the Alps or in the Altai mountains. The three sections which have been established of the genus viz.: *Aretia*, *Chamaejasme*, and *Haplorhiza*, are all represented in the Alps, but the first of these, *Aretia*, is not credited to the Baikal and Altai mountains; it is known, however, from eastern Siberia.

With regard to the development of the genus *Androsace* it deserves attention that even if the European Alps may be considered a most important centre owing to the larger number of species, including several endemic, then the Rocky mountains must, nevertheless, constitute another, and of no smaller importance. It is true that the genus in the Alps is accompanied by a close ally, the monotypic *Aretia*, an ally so close that several authors have united it with *Androsace*, but on the other hand we have on this continent an ally, *Douglasia*, with four species, which is also closely related to *Androsace*. In other words, the actual presence of these two genera on our continent seems to indicate that the Primulaceae have also had a centre of development in America. And the distribution of *Douglasia* speaks in favour of this supposition.

Douglasia nivalis Lindl., *D. montana* Gr., and *D. laevigata* Gr. are natives of the Rocky mountains and the Cascade mountains, principally at higher elevations; *D. arctica* Hook., on the other hand, is known only from the arctic seashore. In other words, these two genera, being arctic or alpine, may well be considered as representing a high-northern centre of the Primulaceae. *Douglasia arctica* being a truly arctic type, and *Androsace Chamaejasme* being quite common on the arctic shore, including the archipelago, and sometimes accompanied by *A. septentrionalis* and *A. Gormani* Greene, this little alliance may indicate a former centre located in the polar regions; moreover, we remember that *A. Chamaejasme* is almost circumpolar.

The present more advanced development of these two genera farther south in the Rocky mountains may have had its origin from an arctic centre. The fact that both *A. Chamaejasme* and *A. septentrionalis* are known also from the Altai and Baikal mountains indicates that they came from the north. In Europe these same species migrated as far south as to the Alps and even to Caucasus, where they are still in existence. The approximately circumpolar distribution of *A. Chamaejasme* in connection with the exclusively arctic one of *Douglasia arctica* thus seems to illustrate an instance of a single centre being located in the arctic regions, although the genera in question are at present more amply represented farther south, the former in mountains as remote as the Alps, the Altai, and the Rocky mountains. But with regard to the other species of *Androsace*, these must have originated in the south, the Alps and the Altai mountains, since none of these show any evidence of having existed farther north, at least not in the polar regions.

Gentiana arctophila Griseb. and *G. propinqua* Richards. are the only species collected by the expedition of the genus; *G. glauca* Pall. was found by Kjellman at Port Clarence, Alaska. It seems quite remarkable that the two former ones have been found in the arctic region, since they are annual for, as we know, annual plants are extremely rare in the polar regions; *Koenigia* is generally cited as the only annual plant in the arctic; with respect to the third species, *G. glauca*, this is perennial according to Grisebach in Ledebour's Flora (l.c.). However, when comparing the representation of *Gentiana* in the polar regions altogether we notice that of the six species credited to arctic Russia five are also annual or sometimes biennial; and the same is the case of those recorded from arctic Scandinavia as well as from Greenland. The accompanying table (Table 7) will show the species represented in the arctic zone and their general distribution; thus we may obtain a better view of the representation of the genus at these high-northern latitudes as well as in the mountains farther south. It may be stated, at the same time, that *G. tenella* extends as far north as Lat. 71° on the east coast of Greenland (Dusén) and that the six species enumerated as arctic Scandinavian have been reported from Lat. 70° to 71° 10′ in Finmark.

TABLE 7.

Geographical distribution of arctic Gentianae.

	Polar Regions										
	Arctic America	Greenland	Arctic Scandinavia	Arctic Russia	Arctic Siberia	Alps and Pyrenees	Ural	Caucasus	Altai mountains	Kamtchatka	Rocky mountains
G. Amarella L.			•	•		•	•	•	•		
G. campestris L.			•			•	•				
G. tenella L.	•	•	•	•	•	•			•		•
G. propinqua Richards	•				•						•
G. arctophila Griseb.	•										•
G. aurea L.		•	•	•							
G. serrata Gunn.		•	•	•					•		
G. nivalis L.		•	•	•		•					
G. verna L.				•		•		•	•		
G. glauca Pall.	•	•			•					•	•

Furthermore, with respect to the altitudes reached by some of these species in the mountains, the Scandinavian species, except *G. serrata*, ascend to an altitude of between 3,000 and 4,500 feet according to Blytt (Norges Flora); in the Alps of Switzerland, Heer (l.c.) has recorded *G. campestris* and *G. tenella* from 8,500 feet, *G. nivalis* from 9,000 feet, and *G. verna* from 10,000 feet; in the Altai mountains *G. tenella* and *G. verna* ascend to 6,500 feet, and finally in the Himalayas *G. aurea* and *G. tenella* reach an elevation of not less than 10-14,000 feet, according to Hooker (l.c.).

However, several of these are more typically lowland plants occurring for instance on the seashore, notably *G. serrata*, *G. campestris*, *G. Amarella*, and *G. aurea*.

In other words, some of these arctic representations of *Gentiana* occur as annuals or biennials, as alpine or lowland plants, and evidently they all have developed in the temperate regions, *G. glauca*, *G. propinqua*, and *G. arctophila* on this continent, the remaining in Eurasia. However, the occurrence of *G. tenella* in the Rocky mountains of Colorado is difficult to connect with its wide distribution in Europe unless we presume that the species did originate from two centres, one in the Rocky mountains, and a second in temperate Europe, Scandinavia, for instance. And we are confronted with the same difficulty when we attempt to locate the centre for the high-alpine *Gentiana frigida* Hke. Of this the typical plant is known only from the Carpathian mountains but a variety *algida* Pall. (*G. Romanzowii* Griseb.) occurs in Siberia: Terra Tschuktchorum, Altai and Baikal, besides on this continent in the Rocky mountains of Colorado and Utah; it is recorded also from St. Paul and Shumagin islands, Alaska. I cannot believe that this species developed from a single centre, in Eurasia or on this continent. The Carpathian mountains as well as Altai and the Rocky mountains constitute centres of the greatest importance to the distribution and development of *Gentiana*, and the remoteness of these stations in connection with the association of the species with several allied types may, I believe, indicate its origin from these three mountain ranges.

Pleurogyne carinthiaca Griseb. is a native of the European Alps but it is absent from the Pyrenees; it occurs, however, in Caucasus, Ural, Altai, Baikal, Davuria, Kamtchatka, and the Himalayas (10-13,000 feet); on this continent it has been found in Canada, but only at a very few stations, viz.: Anticosti and Rivière du Loup, Quebec, besides on the arctic coast explored by the expedition, the only arctic stations thus so far recorded. The wide distribution in the south speaks in favour of its actual centre having been located there but it is, of course, impossible to decide whether in Europe or in Asia. The occurrence in North America evidently depends on its distribution from Kamtchatka to the islands of Alaska, rather than suggesting an independent development of the species on this continent where it is, as far as we know, so extremely rare and represented only by specimens of diminutive size and very few-flowered.

The other species, *P. rotata* Griseb., is in Europe only recorded from arctic Russia while in Asia it is known from Altai, Baikal, and Davuria; it is rare on the west coast of Greenland, between Lat. 60° and 69°, while on the American continent it is distributed from Labrador and Hudson bay to the northwest coast of Alaska; it also occurs in the Rocky mountains as far south as Colorado where it is not alpine. It is evidently of southern origin, but of course the actual centre of its distribution cannot be decided. We have thus in the genus *Pleurogyne* two species which are annual and of which the distribution extends across an area of enormous extent throughout the northern hemisphere, but of which *P. carinthiaca* has reached a wider range in Europe, viz.: to the Alps and Caucasus. It seems strange that the Gentianaceae, though principally high-alpine, are so scantily represented in the polar regions, and especially by annual or biennial types.

The almost exclusively American family Polemoniaceae is in the arctic regions but poorly represented. *Polemonium boreale* is circumpolar, and outside the polar regions it has only been found in the Altai mountains. It is thus absent from the Rocky mountains which otherwise constitute such an important centre of the genus. It would seem very strange if this species were of a more southern origin since, at present, it is almost confined to the arctic region, and especially because, as stated above, it is absent from the Rocky mountains. And with respect to the other species of the genus, the variety *villosum* is almost circumpolar, while the typical plant is widely distributed in the south, in Europe, Siberia, and on this continent. It actually appears, by considering the geographical distribution of these plants, as if the genus has

originated from more than one centre, yet given rise to species so closely related as the two in question: *P. caeruleum* and *P. boreale*. The question as to their original centre seems just as complicated as that of *Sieversia*.

A similar difficulty arises when we consider *Phlox Richardsonii*, a member of a genus so exceedingly well exemplified in the Rocky mountains, and yet this species is known, so far, only from a very few stations on the arctic American coast. No other explanation seems plausible than the considering of the species as a remnant of the glacial flora, and as the sole remnant of the genus, formerly distributed much farther north but exterminated with but this exception at the high-northern latitudes.

Very few Boraginaceae have been found in the arctic region. Ledebour, for instance, mentions only 1 species of *Mertensia*, 4 species of *Myosotis*, 1 species of *Eritrichium*, and 2 species of *Echinospermum* as occurring in arctic Russia, and only 1 species of *Myosotis*, and 1 of *Eritrichium* as inhabiting arctic Siberia; no additional species are recorded by Kjellman from the north coast of Siberia.

Of these *Myosotis silvatica* was found on the north coast, but only the typical plant; in the arctic region the variety *alpestris* Koch is more common and, as described by Ledebour as being "humilior, racemis brevioribus densius incumbenti-pilosis, pedicellis crassioribus, calycibus majoribus" it is quite distinct from the type. According to Ledebour the typical plant has been found in arctic Russia but nowhere in Siberia, except in the Altai mountains and Davuria.

While *Mertensia paniculata* has been reported from many stations in Canada and the United States, *M. Drummondii* has never been found outside the north coast where, moreover, it seems to be extremely rare. These two species belong to the section *Eumertensia* which is quite well represented in the Rocky mountains especially, and the occurrence of *M. Drummondii* solely on the north coast may be explained in the same manner as that of *Phlox Richardsonii*. But with respect to *M. maritima*, this is a seashore plant and, although wholly absent from the Siberian coast, it is not infrequent on the arctic coast of this continent, as well as in Greenland and arctic Europe. Being a seashore plant, and at present so widely distributed in Europe and on this continent, the species evidently belongs to the category of plants which originated in the south but gained a more extended distribution toward north when the ice receded, like *Halianthus*.

The large family of Scrophulariaceae is in the arctic region well exemplified by the genus *Pedicularis* but the other genera are very poorly represented; for instance, according to Ledebour: *Limosella*, *Veronica*, *Castilleja*, *Bartsia*, *Euphrasia*, *Rhinanthus*, and *Melampyrum* are the only ones, besides *Pedicularis*, known from arctic Russia; *Veronica*, *Castilleja*, and *Pedicularis* are the only genera known from arctic Siberia. But among these arctic Eurasian genera is one which more properly belongs to the North American flora, viz.: *Castilleja*. Of this genus *C. pallida* and the variety *septentrionalis* Gray, so widely distributed in Canada and in the mountains of the United States, viz.: the alpine summits of the White mountains and Green mountains of New England, and throughout the Rocky mountains, occur, furthermore, in arctic Russia and Siberia, in Ural, Altai and Baikal, in Davuria and in Kamtchatka, besides in Alaska, and in South Greenland. The geographical centre seems naturally located in the Rocky mountains where the species is associated with several closely related congeners and from where it became distributed to the north, extending eastward to the American archipelago and Greenland, westward across Bering strait to Siberia and arctic Russia.

With respect to *Pedicularis*, the accompanying table (Table 8) shows the species which have been recorded from the polar regions. This table comprises only 16 species, a small number, indeed, when we bear in mind not only that 120 species are recognized as "valid species" by Bentham and Hooker but also, and quite especially, that the arctic element represents sections so exceedingly well

TABLE 8.

Geographical distribution of arctic species of Pedicularis.

exemplified farther south in the mountains as well as in the lowlands. Moreover, as stated by Bentham and Hooker, the genus is decidedly a northern, principally mountainous, or even alpine one. A marked characteristic of the genus is the ability to produce species endemic to the mountains where it grows; for most of these endemic species are inhabitants of the mountains. The following instances may be mentioned. Of the 31 species known from North America 18 are endemic; 29 species are recorded from Altai, 14 of which are endemic; of the 22 species recorded from Central Europe, 11 are endemic; of the 10 species recorded from Caucasus, not less than 8 are endemic; of the 9 species recorded from the Pyrenees, 2 are endemic; but of the 22 species known from Baikal only 2 are endemic, and a corresponding small number is represented by Davuria with its 21 species only 3 of which are endemic. In other words, the Altai mountains and Caucasus represent the most important centres of the development of the genus into species. Another important centre is the Rocky mountains and the Coast mountains where several species have developed; Central Europe, especially the Alps, constitutes also a centre of importance. But, although Baikal and Davuria are rich in species of the genus, most of them are also natives of the Altai mountains. As far as concerns Scandinavia with its relatively large number of arctic plants in general, the genus has, as far as it appears, not developed there for there is no endemic species of the genus and, on the whole, the number of endemic species of other plants is surprisingly small in Scandinavia, considering the composition of its flora with so many different types inhabiting the seashore, the valleys, the mountains with their wooded belts and barren summits. And

even if the Scandinavian inland ice forced the plants to migrate to the south there might, nevertheless, have been time and conditions later on to give rise to some endemic element even though the geographic position of the country is rather northern. For, as pointed out by Nathorst, the Alps, in spite of their relatively young age, possess many alpine species about two-thirds of which are endemic to these mountains.

If now the question be asked where the arctic American species originated, we might suggest that the circumpolar species came from the arctic regions. But the objection naturally will be made that these, viz.: *P. lapponica*, *P. hirsuta*, and *P. sudetica* are at present better represented in Siberia where, moreover, they are associated with allied species. And the Siberian alliance of *Pedicularis* corresponds better with the circumpolar than does really the North American.

The genus is well represented in the Himalayas, since Hooker (Flora of Br. Ind. l.c.) has credited 35 species to these mountains; of these 2 occur also in Altai, 2 in Baikal, while *P. verticillata* and *P. Oederi* are, as we know, widely distributed farther north, east, and west; the remaining 29 species are endemic to the Himalayas.

Several of the arctic species reach a considerably high latitude, for instance those recorded from Spitzbergen; with regard to the Greenland species, *P. hirsuta* extends to Lat. 81° 7′ on the west coast, and to Lat. 74° 40′ on the east coast (Dusén); furthermore, *P. lapponica*, *P. lanata*, and *P. capitcta* are reported from resp. Lat. 78° 18′, Lat. 79°, and Lat. 78° 18′ on the west coast; *P. flammea* reaches Lat. 74° on both coasts. And with regard to the altitude which the species attain in the mountains, *P. silvatica*, *P. lapponica*, and *P. Oederi* ascend to about 3,000 feet in Norway; in the Alps of Switzerland *P. verticillata* has been recorded from 9,000 feet (Heer, l.c.), and in the Himalayas most of the endemic species are alpine and several reach an elevation as high as 14-16,000 feet; *P. verticillata* and *P. Oederi* are in these mountains reported from resp. 13,000 and 15,000 feet.

With regard to distribution, *P. verticillata* exhibits the widest distribution especially southward, extending to the Alps of Switzerland, Altai, and the Himalayas; in the north it is absent from the arctic American archipelago, Greenland, Spitzbergen, and Scandinavia; thus it cannot be considered circumpolar. The present distribution of the species in the north, and at the same time its occurrence in the Alps, seems to indicate the probability of it having had a former, more extensive distribution northward during the glacial epoch. *P. flammea*, absent from Siberia but present in the arctic American archipelago, in Greenland, Scandinavia, Russia, and even in Iceland and the Alps, evidently originated in the north and presumably in the arctic regions of this continent and of western Europe. On the other hand, *P. Oederi*, totally absent from North America and Greenland but extending from Kamtchatka through Siberia and Russia to Scandinavia and present in Altai and the Himalayas, may have had the centre located in the north of the Eurasian continent since it is not at present a southern species either in Europe or in Asia. *P. euphrasioides* is a genuine American type with several close allies in the Rocky mountains, and the Asiatic element of this species came undoubtedly from this continent where it is widely distributed south of the arctic region, from Labrador throughout the continent to Bering strait. While *P. arctica* is known only from arctic America, Siberia, and Kamtchatka, *P. lanata* occurs also in Greenland, Spitzbergen, and Nova Zembla, but they both evidently originated from the polar regions of these two continents, America or Siberia; the same may be the case also of *P. capitata*. The very local *P. Kanei* replaces *P. arctica* in Greenland; *P. villosa* "nulli affiniam consocianda," as stated by Ledebour (l.c.), is a Siberian type. With respect to *P. groenlandica* of the section *Rhyncolophae*, this is confined to the

American continent where it is widely distributed from Labrador and Hudson bay to the alpine and sub-alpine Rocky mountains, extending south to the borders of New Mexico, west to British Columbia, and south in the Sierra Nevada to King's river in California.

Typical *P. palustris* does not occur on this continent but is represented by the variety *Wlassoviana* Bunge, "floribus minoribus galea rectiuscula obtusa," a native also of Baikal and Davuria; on the other hand, the type does occur in the arctic regions outside of America but is much more common farther south where it evidently developed; thus the species illustrates a case of two geographic centres, both south of the arctic region, from which two forms developed but modified to such a small extent that they can be considered only as forms of one species.

The small family Selaginaceæ is in the arctic region represented by the genus *Lagotis* Gaertn. (*Gymnandra* Pall.); the genus comprises, according to Bentham and Hooker, eight species which are natives of Central Asia, some of which extend to the arctic regions. In North America *L. glauca* Gaertn. with the variety *Stelleri* (Cham. et Schl.) is credited to Alaska and adjacent islands. While the variety has been reported from several stations in arctic Siberia, from St. Lawrence bay (Kjellman) to Ural, it seems to be very rare in Russia: "Terra Samojedorum versus cacumen montis Sorolop. in vicinia promontorii Mikulkin (Ruprecht)," and it is absent from Scandinavia, Greenland, and the arctic American archipelago. The genus must be of Asiatic origin.

Valeriana capitata Pall. and *V. officinalis* L. are the only species of the genus which have been found in the arctic regions; of these the latter does not grow in America except as an escape from gardens. *V. capitata*, on the other hand, is by Macoun (Catal. l.c.) recorded from cool woods and by brooks, generally in the mountains and on the arctic shore; it is rare in arctic Russia, and with regard to Siberia Kjellman gives the distribution as follows: Konyam Bay, St. Lawrence Bay, Terra Tschuktschorum, Kolyma River, mouth of the River Olenek and Lena, Tajmyr River, and the mouth of the River Jenisej; it occurs also in Caucasus, Altai, and Baikal. As a species it occupies a somewhat isolated position in Russia and Siberia since the nearest allies are natives of southern regions, notably Caucasus.

On this continent there are four species in the northern Rocky mountains two of which, *V. uliginosa* and *V. sitchensis*, may be considered as close allies; it would thus appear as if the genus has a centre of distribution and development on this continent located in the northern Rocky mountains. In the Old World, Caucasus with its nine species, four of which are endemic, must constitute another centre, and the fact that *V. capitata* is among the species indigenous to these mountains might indicate that the species has had a dual origin; it certainly would be difficult to combine these two centres with each other, not only on account of the great distance, but also on account of the very distinct element developed in these mountains.

Of the 230 species of *Campanula* recognized by Bentham and Hooker, "per hemisphaerium boreale late dispersae, in regione Mediterranea imprimis orientali copiosissimae," some few have spread to the arctic regions; among these *Campanula uniflora* is recorded from latitudes as far north as 79° on Spitzbergen (Eaton); 76° 7′ on the west coast of Greenland, Cape York (Nathorst), and 74° 40′ on the east coast (Dusén). However, the fact that, so far, only four species have been recorded from the arctic regions seems surprising when we consider the distribution of the genus in Europe, in the mountains of Central Europe and Caucasus especially. For in the mountains of Switzerland, Austria, and Germany not less than 21 species are indigenous, several of which are alpine; and with regard to Caucasus 20 species have been recorded from these mountains, 11 of which are endemic. But as indicated above, the Mediterranean region

contains the most important centres of the species of this genus. We might quote from DeCandolle's excellent monograph[1] the data as follow: Spanish Peninsula: 18 species, 6 endemic. Italy and Dalmatia: 36 species, 11 endemic. Greece and Asia Minor: 36 species, 24 endemic. France, Corsica and Sardinia: 13 species, none endemic.

With regard to Siberia, 11 species are known from Ural, 10 from Altai, and 7 from Baikal. Nevertheless, the number of arctic species is extremely small, viz.: *C. uniflora* L., *C. lasiocarpa* DC., *C. rotundifolia* L., var. *arctica* Lge., and *C. groenlandica* Berlin;[2] and strange to say, *C. uniflora* is absent from Russia and Siberia with the only exception of Konyam bay, where Kjellman found it, Nova Zembla, and Arakamtschetschene island (C. Wright).

Still the species occurs in Scandinavia, Spitzbergen, Greenland, the north coast of this continent, including the archipelago, besides from Labrador to Alaska, and south to the Colorado Rocky mountains.

By the structure of the flower and the capsule, besides by the habit, *C. uniflora* appears to be an ally of *C. cenisia* L., a native of the alpine regions of the Alps. But it shows no immediate affinity with *C. lasiocarpa* Cham. except "capsula lateraliter versus apicem dehiscente." DeCandolle regards *C. lasiocarpa* as an ally of some Siberian species, notably *C. Adami* Bieb. and *C. dasyantha* Bieb., but it differs from these, however, by the sinuses of the calyx being only minutely appendiculate; *C. lasiocarpa* is a native of the alpine summits of the high-northern Rocky mountains and of the northwest coast and islands; *C. dasyantha* (*C. pilosa* Pall.) inhabits Alaska and the Aleutian islands, Kamtchatka and eastern Siberia; *C. Adami*, on the other hand, is a native of Caucasus.

We have thus in these species of *Campanula*, represented in the arctic regions, a commingling of types among which *C. uniflora* occupies a somewhat isolated position; considering the wide distribution on this continent where it is either arctic or alpine, it seems probable that *C. uniflora* is a member of the old glacial vegetation, and that the centre of its distribution was located in the arctic regions of this continent. The occurrence of this species in Scandinavia is one of the several cases which Nathorst has mentioned as demonstrating the probable road of migration of the American element across Greenland to Iceland and Scandinavia. With regard to *Campanula rotundifolia*, this is not an arctic type, judging from its predominant distribution southward, but the species is evidently one of those that accompanied the arctic flora on its retreat to the north. But in the arctic regions *C. rotundifolia* has developed a type, "*C. groenlandica* Berl.," which together with the variety *arctica* Lge. thus represents the species in the far north

As regards *C. lasiocarpa* on the northwest coast, this is undoubtedly of Siberian origin, as indicated by DeCandolle, and the same is the case of *C. dasyantha*. The analogy in floral structure, through which these appear to be related to the Caucasian *C. Adami*, is one of the many instances of analogous structures being possessed by plants at stations ever so remote and resulting, sometimes I believe, in the development of identically the same species.

If we finally consider the Compositae, a score of species is all that the expedition brought home from the north coast, and nowhere in the arctic is this family much in evidence in proportion to its size, some 12,000 species having been described. From arctic Russia and arctic Siberia we have only record of about 50 species according to Ledebour (l.c.), while from the small area of arctic Scandinavia Hartman (l.c.) has enumerated about 50 species, 18 of which are *Hieracia;* in Greenland the family is represented by about 30 species 10 of which are introduced weeds, principally at the colony Ivigtut.

[1] Alphonse DeCandolle: Monographie des Campanulinées. Paris, 1830.
[2] Kärlväxter, insamlade under den Svenska Expeditionen till Grönland 1883, l.c. p. 50.

Concerning the material collected, *Aster sibiricus* is the only member of the genus represented; it is not confined to the arctic coast, however, and occurs also in Alaska with adjacent islands, besides in the Rocky mountains of Wyoming and Montana; it is not arctic in Siberia, but is reported by Ledebour from Altai, Baikal, and Davuria. *Aster alpinus* L. and *A. pygmaeus* Lindl. have both been collected in the arctic regions of this continent to which the latter is confined; the former occurs also in the Rocky mountains down to about Lat. 19° (Drummond) and is, furthermore, indigenous to Central Russia, Caucasus, Altai, Baikal, and Davuria. *Aster Tripolium* L. grows in Finmark, mostly represented by the variety *arcticus* Th. Fr.

In *Erigeron* we have the circumpolar *E. uniflorus*, also widely distributed in the south, frequently accompanied by *E. alpinus*. *E. grandiflorus*, and *E. compositus*, on the other hand, are better represented in the Rocky mountains where they evidently developed. As a matter of fact these mountains, rich as they are in species of the genus, constitute one of the most important centres: only seven species have been reported from Caucasus two of which are endemic, and the same figures may also be applied to Altai.

The circumpolar *Antennaria alpina* may well be considered as one of the parental types from which the North American element has developed. It is interesting to notice the abundance of species of the genus which are represented on this continent, even though much too many have been proposed, in comparison with the representation of the genus in the Old World: *A. alpina* (L.) R. Br., *A. carpathica* R. Br., *A. dioica* Gaertn., *A. rubicunda* Koch (Armenia), and *A. Steetziana* Turcz. (Baikal, Davuria); however, the last of these is by Trautvetter (Increm. p. 412) considered identical with *Leontopodium sibiricum*.

Chrysanthemum integrifolium and *C. arcticum* are the only species of the genus indigenous to North America; of these the former is confined to the arctic sea coast and "Terra Tschuktchorum" while the latter extends from Hudson bay to arctic Alaska, Kamtchatka, eastern Siberia (Pitlekaj Long. 173° 24′ W.); it has also been found in Lapland.

While the genus *Pyrethrum*, a near ally of *Chrysanthemum*, on this continent is only represented by a single species, the arctic *bipinnatum* Willd., it is in Siberia and Russia exemplified by about 40 species, mostly natives of Altai and Caucasus.

About 120 species of *Artemisia* are recorded from Russia and Siberia by Ledebour and Trautvetter, and about 60 from this continent; most of these are lowland plants but some have also been recorded from the mountains, notably from Caucasus (about 20 species), Altai (about 40 species), and the Rocky mountains (about 15 species).

Some of the American element is best represented in the arctic regions, for instance: *A. Richardsoniana*, *A. senjavinensis* Bess., *A. glomerata* Ledeb., *A. globularia* Cham., and *A. borealis* Pall., where they evidently developed, and these regions may thus have constituted an important centre for several of the alpine species farther south; some other centres, and perhaps still more important to the development of species, may have been situated in Caucasus and Altai.

The large genus *Senecio* is also well represented in Eurasia and North America but very few occur in the arctic region; these are mainly the same species and they are almost circumpolar.

Crepis nana Richards. is by Ledebour referred to the genus *Youngia* and it is the only one known from this continent, being distributed from the arctic coast and islands south along the mountains to Colorado and California; in Asia the species has been reported from Altai, Baikal, and Davuria. Some other species of *Youngia* are described by Ledebour, one from Caucasus, and 3 from Altai, Baikal, and Davuria. It would thus appear as if this singular little genus

has developed in the mountains as far apart as Caucasus and Altai; the American species undoubtedly originated in Altai, and its occurrence on the arctic shore may simply indicate the road it followed from these mountains across the Bering strait. It is a peculiar fact that the species, in spite of this enormous range eastward and southward, has developed no varieties on this continent as is the case with the plant in Altai, Baikal, and Davuria.

CHAPTER III. CONCLUDING REMARKS.

The vegetative structures described in the preceding pages are those exhibited by arctic plants in general, and the examples cited are from material gathered on the north coast of this continent. As a feature especially characteristic is the persisting primary root, frequently developed as a thick fleshy taproot, and well represented in various genera, as for instance: *Rumex, Papaver, Parrya, Oxytropis, Campanula, Artemisia,* etc. Or the root-system may be represented by a series of secondary, slender roots proceeding from a horizontally creeping rhizome, as for instance in *Saxifraga aestivalis, Pedicularis sudetica, Lagotis, Valeriana, Arnica, Saussurea,* etc. The tuberous roots so characteristic of *Ficaria* and *Corydalis* are rarely observed in these regions: however, *Ficaria* does occur in arctic Europe, and Kjellman discovered th tuberous-rooted *Corydalis pauciflora* Pers. at Port Clarence.

Then with regard to the subterranean stem, this may be quite thick and sparingly branched, lacking the slender, horizontally creeping ramifications known as stolons; this simple structure is found in *Polygonum viviparum, Lagotis, Valeriana, Arnica,* and *Saussurea.*

More frequently the rhizome develops stolons, often attaining a considerable length. This structure is exceedingly well represented by many Gramineæ, Cyperaceæ, and by a number of species belonging to different genera of the Dicotyledons, for instance: *Polygonum Bistorta, Oxyria, Stellaria longipes, Merckia, Halianthus, Anemone parviflora* and *A. Richardsonii, Ranunculus lapponicus, Polemonium,* various species of *Pedicularis, Petasites,* etc.

Aerial stolons are, of course, seldom met with but they are, nevertheless, profusely developed in *Glyceria vilfoidea, Ranunculus Cymbalaria, Saxifraga flagellaris,* and *Androsace Chamaejasme.*

Pseudo-rhizomes, we have seen, are not infrequent; they are characteristic of several members of the Caryophyllaceæ, *Cerastium,* for instance, also *Chamaenerium,* various Papilionaceæ, etc.

The bulb so characteristic of the Liliaceæ is found in *Lloydia,* in *Allium sibiricum,* and among the Melanthaceæ in *Zygadenus glaucus.* However, this type of stem recurs in some of the dicotyledonous genera, notably in *Saxifraga cernua* and *S. rivularis,* or as a secondary structure caused by transformation of flowers in *Saxifraga cernua, S. stellaris* forma *comosa, Polygonum viviparum,* and to some extent in the viviparous *Aira alpina* and *Festuca ovina.*

As to the stem above ground we notice quite a considerable variation among the herbs ranging from the simple leafless scape emerging from a rosette of leaves in *Primula, Dodecatheon, Ranunculus Cymbalaria, Saxifraga aestivalis,* to the amply ramified shoots of all those species which have the cushion-like structure known so well from these regions. As examples may be mentioned *Silene, Douglasia, Phlox, Saxifraga tricuspidata, S. bronchialis, Chrysanthemum integrifolium, Oxytropis arctobia, O. nigrescens,* etc.

Among the woody plants there are several, more or less prostrate shrubs, represented by the willows, by *Betula, Empetrum, Dryas, Vaccinium, Rhododendron. Loiseleuria,* etc., and even trees are not absent as the presence of *Picea canadensis* testifies.

Concerning the foliage, there are many different types from simple, entire to lobed or cleft, or compound: *Papaver, Artemisia, Polemonium, Selinum,* the Papilionaceæ, Rosaceæ, etc. Glabrous and hairy leaves are almost equally common, but succulent leaves are seldom met with; *Rhodiola* may be mentioned as an instance. In several of the herbs the leaves persist throughout the winter, and several of the shrubs are evergreen, for instance: *Dryas, Empetrum,* the Ericaceæ, etc., not speaking of *Picea.*

There are also many types of inflorescences represented in these regions but the umbel is rare; and with regard to the floral structure, the actinomorphic and zygomorphic ones are both common and almost equally represented. With regard to the fruit, the fleshy type is rare and does not seem to mature every year as is evidenced in the genera *Vaccinium*, *Empetrum*, *Rubus*, and *Arctostaphylos*.

Certain biological types of plants are totally absent from the polar regions; there are no climbers and no true parasites of the *Cuscuta* or *Arceuthobium* type; yet *Pedicularis* is a root-parasite but one having a green foliage; saprophytes seem to be absent altogether.

Thus, with but a very few exceptions, viz.: *Pedicularis*, the arctic flora is composed of autophytes, herbs as well as shrubs, with the great majority of the herbs perennial, *Koenigia*, *Gentiana*, and *Pleurogyne* being the only annuals in arctic North America, not including a few accidentally introduced weeds.

Considering the general characteristics of the arctic plants, one cannot help but recall the picture of the alpine flora in general. Practically, the arctic flora is diversified to the same extent and represented by the same elements; the families, genera, and species are either identically the same or represented by analogous types, some of which may be endemic while others may have immigrated from other districts. This similarity in composition existing between the arctic and the alpine floras, as well as the analogy in the morphological structure of the plants, is, nevertheless, associated with such diversities of conditions as offer, for instance, the tundras of the arctic and the alpine summits of the south.

Concerning the origin of the arctic and of the alpine vegetation as it now exists, it may be mentioned that Nathorst is in favour of the supposition that the arctic vegetation, at least to some extent, originated in the lowlands of the polar regions, but that the greater portion was originally alpine. To draw the line between these two elements seems impossible, even if we may feel entitled to consider most of the circumpolar species to have originated in the north; and besides, there are quite a few species which are not circumpolar but, nevertheless, better represented in the north where they are more abundant; these may also be considered remnants of an arctic vegetation.

With the morphological structure so remarkably uniform in the arctic and alpine elements, we must consider them from another viewpoint, namely as "species." Developed as such, the arctic element appears, sometimes, as more or less isolated types like *Pleuropogon*, *Dupontia*, *Arctophila*, *Tofieldia*, *Oxyria*, *Koenigia*, *Monolepis*, *Merckia*, *Douglasia*, *Pachypleurum*, etc. Or we may trace an arctic origin in species of even large genera, whether circumpolar or simply arctic. For instance, *Saxifraga* contains types some of which are decidedly of arctic, others of alpine origin, as demonstrated in the preceding pages. *Ranunculus*, *Stellaria*, *Potentilla*, and several other genera, not speaking of the Gramineae and Cyperaceae, also illustrate such diversity of origin, arctic or alpine.

As a matter of fact, several of the genera characteristic of the polar regions are monotypic or nearly so; or in case of large genera, the arctic species are not infrequently somewhat isolated, i.e. from a systematic point of view, as if actually representing glacial types of the respective genera. I think especially of *Campanula uniflora*, *Polygonum viviparum*, *Eutrema Edwardsii*, *Braya purpurascens*, *Parrya macrocarpa*, *P. arctica*, *Ranunculus glacialis*, *R. Pallasii*, *Saxifraga flagellaris*, *Salix polaris*, *S. reticulata*, etc. And judging from their present geographical distribution I take these to be arctic types having originated in these regions and acquired a specific structure which makes them distinct from such of their congeners as are also distributed in the arctic regions but of which the original centre appears to have been located farther south, and principally in the higher mountains.

With regard to the American element of the arctic flora, this is distinct when we compare the corresponding one of Europe and Asia, but it is not very large. We notice, for instance, *Calamagrostis purpurascens*, *Salix Richardsonii*, *Anemone Drummondii*, *A. parviflora*, *Ranunculus Sabini*, *Lesquerella*, *Hesperis*, *Cardamine digitata*, *Parrya arctica*, *Parnassia Kotzebuei*, *Saxifraga tricuspidata*, *Dryas integrifolia*, *Potentilla Vahliana*, *Lupinus*, *Hedysarum*, *Phlox*, *Erigeron compositus*, *E. grandiflorus*, etc. But considered on the whole the vegetation of the north coast is, as stated in the preceding, composed of types from various parts of the northern hemisphere of both Worlds. It will thus be seen from the geographical table, that the arctic coast of this continent has 88 species in common with Altai and Baikal, 61 species in common with the Alps and Pyrenees, 39 in common with Caucasus, 44 in common with the Himalayas, and 106 in common with arctic Scandinavia.

In other words, the migration of the glacial plants cannot be disputed, and, no doubt, the present arctic flora consists to a great extent of remnants of the alpine floras of the tertiary period. And these alpine floras were principally those of the European Alps, Altai, and Baikal, the Rocky mountains, and perhaps also Caucasus and Scandinavia. With regard to Scandinavia, Nathorst calls attention to the fact that while these mountains, at least at present, have but a very few endemic, alpine species, we must bear in mind that owing to the enormous extent of the Scandinavian inland ice the original Scandinavian flora became dispersed towards east, south, and southwest, and intermingled with elements from the Alps and northern Asia.

Consequently, when the ice receded and the Scandinavian mountains were again covered with vegetation, the probability is that the post-glacial flora was not the same as the original one, but evidently a commingling of types from various mountain ranges farther south. Therefore, we cannot expect that the present Scandinavian mountain flora may guide us as far as to obtain some idea of the pre-glacial flora of these mountains, if such had really been in existence.

However, the question as to the alpine origin of the vegetation depends upon the age of these mountains. As stated by Nathorst, the highest mountains were formed during the tertiary period: the Himalayas, the Cordilleras, the Alps, the Pyrenees, Caucasus, the Rocky mountains, and perhaps even some of the Spitzbergen mountains; but we do not know the age of the mountains of Greenland and Scandinavia. In this way we are obliged to suppose that the alpine and arctic floras, or better their nearest ancestors, in the northern hemisphere are, to a great extent, of a relatively recent date, in any case not older than the eocene period, or even a more recent one. Nevertheless, even though the Alps were formed as late as the pliocene period, the flora of these mountains contains more than 400 alpine species which seemingly owe their origin to these mountains, and many were perhaps not developed until after the glacial epoch.

Finally with regard to the geographical distribution of some of the species which are not circumpolar and which evidently originated in some area south of the arctic regions, we have seen that the present distribution might lead to the acceptance of the theory, proposed by Schouw, at least in some cases. And there are cases where we cannot explain how the same species could have passed from one point to the other. And even if the geographical and climatologic changes which have occurred within recent geological times must have interrupted or rendered discontinuous the formerly continuous range of many species, there are some cases which may well be considered exceptional. I think especially of the Pyrolaceae.

Owing to the present distribution of these in both Worlds, with some of them being almost equally well represented on this continent and in Europe, but being so very scantily represented in Asia, none being alpine, and only one being, as I presume, of arctic origin, it seems very difficult to locate the actual centre of their distribution and development.

They constitute a very natural little family; with the exception of *Pyrola grandiflora* and the typical *P. rotundifolia*, they are sylvan types and they often grow associated with each other forming small colonies; reproduction by means of root-shoots is characteristic of several of the species. We have seen from the geographical table (Table 6) how *Pyrola minor* extends clear across the northern hemisphere, reaching the arctic regions on this continent, including Greenland, in Scandinavia, and in Russia; a similarily wide distribution is exhibited by *P. rotundifolia*, it being absent only from our arctic coast, Greenland, and Iceland, and by *P. secunda* which is absent from the northeastern corner of Asia: Terra Tschuktchorum and Kamtchatka. Then with regard to *Moneses*, this shows the same distribution as *P. secunda* but is absent from Caucasus. Finally, *P. chlorantha* is absent from ten of the eighteen districts enumerated on the table, namely: our north coast Greenland, Russia, Siberia, and Iceland, but it is represented in Europe from Finmark south to the Alps and the Pyrenees.

We have thus four species of a remarkably wide distribution in both Worlds. Nevertheless, the Pyrolaceae are best represented on this continent, the home of three species of *Chimaphila*, besides of *Pyrola elliptica*, *P. picta*, *P. chimaphiloides*, and *P. aphylla*, and the foliage of the last three species resembles that of *Chimaphila* more than that of *Pyrola;* in Europe there is a somewhat isolated type: *P. media*. It is interesting to notice that while *P. chlorantha* is absent from Asia, Maximowicz [1] discovered a near ally of it, *P. renifolia*, in coniferous woods in the Amur district where, moreover, *P. secunda*, *P. rotundifolia*, *Moneses*, and *Chimaphila umbellata* were collected.

It would thus appear as if the centre of the Pyrolaceae might have been located on this continent, rather than in the Old World, inasmuch as the Monotropeae, the nearest allied family, are also best represented here, with seven mostly monotypic genera of which *Monotropa* is the only genus occurring also in Europe.

However, when we bear in mind that *P. minor* and typical *P. rotundifolia* are much more abundant in Europe than on this continent, it might be more orrect not to include them in the American element, I mean the element which presumably originated on this continent.

With respect to *P. chlorantha* it seems difficult to combine its distribution in Europe with that on this continent and, as stated above, it is absent from all of Asia. The occurrence of *Chimaphila umbellata* in Europe causes also some difficulty but its distribution in Asia, Altai for instance, may point towards a former, much wider distribution, at present disconnected.

Taking all points into consideration it seems a most difficult task to treat the distribution of this singular little family, almost exclusively confined to the temperate regions of both Worlds, and being mostly sylvan types. For whether their centre of distribution, or let us say development, be placed on this continent or in Europe, the question will necessarily arise how these little plants have remained so unchanged on both continents when, as stated by Darwin,[2] "by comparing the now living productions of the temperate regions of the New and Old Worlds, we find very few identical species, but we find in every great class many forms, which some naturalists rank as geographical races, and others as distinct species; and a host of closely allied or representative forms which are ranked by all naturalists as specifically distinct."

With respect to the Pyrolaceae some certain "geographical races" have become developed, notably of *Chimaphila umbellata*, *Pyrola secunda*, and *P. rotundifolia*, but, nevertheless, the typical species are represented in both Worlds. Otherwise with respect to the plants with which they are associated.

[1] Primitiae Flor. Amur. l.c. p. 190.
[2] Origin of Species, p. 441.

The following list will show an assemblage of species which accompanies the *Pyrola* alliance on this continent (Maryland and Virginia) and in Europe (Denmark).

Maryland and Virginia	Denmark.
Chimaphila umbellata	*C. umbellata.*
C. maculata	
Pyrola secunda	*Moneses uniflora.*
P. chlorantha	*P. secunda.*
P. rotundifolia	*P. chlorantha.*
P. elliptica	*P. minor.*
Monotropa lanuginosa	*P. media.*
M. uniflora	*M. hirsuta.*
Goodyera pubescens	
Corallorhiza odontorhiza	*C. repens.*
Cypripedium acaule	*C. innata.*
Orchis spectabilis	
Hieracium venosum	*O. mascula.*
Vicia caroliniana	*H. murorum.*
and a little farther north:	*V. sylvatica.*
Linnaea borealis var. *americana*	*L. borealis.*
Trientalis americana	*T. europæa.*

To this list, which only shows some parallel species or genera, may be added several other plants which are also associated with the Pyrolaceae in the vicinity of Washington (D.C.), for instance: *Epigaea, Gaultheria, Mitchella, Obolaria, Cunila, Gerardia, Leptandra,* etc.

From this enumeration may be seen that while the Pyrolaceae have kept unchanged, their associates *Linnaea* and *Trientalis* represent geographical races, the others being species totally distinct.

It is thus an indisputable fact that the Pyrolaceae do occur in their typical form in both Worlds, besides that they, at least some of them, may acquire a more or less modified structure in the various districts where they occur, in the manner of "geographical races."

In view of these facts it seems difficult to explain the present distribution of the Pyrolaceae in any other way than that they have been produced "not in one area alone," but in several. For if the family had originated on this continent and later on migrated to Europe, we might be entitled to expect that some of their associates would have accompanied them; of such we have only *Linnaea* and *Trientalis* both of which represent geographical races, however. But referring to the other plants, none of these has ever been found in Europe. Would it not be natural to expect that at least the allied genera *Epigaea* and *Gaultheria,* showing the same habit as the Pyrolaceae and extending far north on this continent, might have accompanied the Pyrolaceae on their migration to Europe? Westward, on the other hand, we find in Japan *Epigaea asiatica* Maxim., *Mitchella undulata* Sieb. et Zucc., and *Monotropa uniflora.*

It is really astonishing to observe how such an alliance of a few closely related plants have been able to preserve their habit and structure at such enormous distances, as shown according to the longitudes and latitudes, within which they exist.

If the species had been alpine and arctic at the same time, their distribution would be explained in quite a different way, as being the result of migration during the glacial epoch. But now that they are mainly lowland types, their habitat being mostly the wooded belts, the problem of their range calls for another explanation, viz.: the probability of their development from more than a single area.

And even if such dual origin may actually be a rare occurrence, I cannot explain the distribution of *Anemone trifolia*, *Papaver pyrenaicum*, *Lloydia*, and some other plants in any other way than that they have originated from several centres.

In the preceding pages I have discussed the remarkable development of the genus *Sieversia* at several points remote from each other, and although the genus is both arctic and alpine, the origin of the genus may be interpreted in the same light as *Pyrola*, *Moneses*, and *Chimaphila*.

We have seen that *S. glacialis*, *S. Rossii*, *S. calthifolia*, *S. radiata*, and *S. triflora* are natives of this continent, and that *S. glacialis* and *S. Rossii* occur also in eastern Siberia, *S. calthifolia* in Kamtchatka; furthermore, that *S. reptans* and *S. montana* are endemic to the Alps and Pyrenees, *S. elata* to the Himalayas; that *S. anemonoides* is a native of Kamtchatka and Japan, *S. karatavica* Reg. et Schmalh. of Turkestan.

In other words, there must have been more than one centre from where the genus developed, two on this continent, viz.: the arctic coast; a second one in the Appalachian mountains; a third one in the Alps and Pyrenees; and a fourth one in the Himalayas. The arctic element may well be connected with the species in Kamtchatka and Japan, but the other species are so isolated that no connection seems possible. With reference to the species themselves, the structure of the style, it being jointed, wholly persistent and straight, is a constant character in the genus. While the style is glabrous in *S. Rossii*, it is pilose in all the other species; furthermore, the petals are erect, not spreading, and of a reddish colour in *S. triflora*, but in all the others the petals are yellow and spreading. The members of *Sieversia* thus show the same sectional structures as *Geum* with regard to the flowers, viz.: *Caryophyllastrum*: petals white, greenish-yellow to golden-yellow, spreading; *Caryophyllata*: petals purplish, erect.

The nearest ally of *Sieversia* is *Geum*, represented on this continent by eight species, four of which are endemic. Among these *G. macrophyllum* extends to Kamtchatka. *G. strictum* is, on the other hand, widely distributed through Siberia to Central Russia, including Caucasus and the Altai mountains. *G. rivale*, though not infrequent especially throughout the northern parts of this continent, is more generally distributed in Europe and Siberia; *G. urbanum* has become established at Cambridge, Mass.

In the Alps and Pyrenees *Geum* is represented by *G. rivale*, *G. urbanum*, *G. pyrenaicum* Willd., and *G. sylvaticum* Pourr.; of these *G. urbanum* is the only species recorded from the Himalayas.

Another near ally of *Sieversia* is *Dryas* which, as we have seen, occupies much the same territory as the northern species of *Sieversia*, besides occurring in the Alps and the Pyrenees.

Sieversia is thus an excellent example of a genus having developed at immensely remote stations, giving rise to species very closely related to each other, yet absolutely distinct. The rule that the most natural genera, or those genera in which the species are most closely related to each other, are generally confined to the same country or, if they have a wide range, that their range is continuous,[1] can not be applied to *Sieversia*. And several corresponding instances may be cited from other families. We remember the genus *Pleuropogon* of which there is a high-northern type, *P. Sabinii*, and two ones endemic to California, viz.: *P. refractum* Benth., and *P. californicum* Benth.; furthermore, *Claytonia*[2] which is one of the most characteristic genera of North America is in Australia represented by *C. australasica* Hook. and in New Zealand by *C. calycina* Colenso.

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[1] Darwin, C. Origin of Species, l.c. p. 422.
[2] Holm, Th. Types of *Claytonia*. Mindeskr. for Japetus Steenstrup. Kjøbenhavn, 1913.

As the genera *Sieversia*, *Pleuropogon*, and *Claytonia* seem to have been developed at such distant points and to have produced species so closely related, I cannot see any objection to the supposition that the same species may also arise from more than one single area.

I have mentioned these few data as a mere suggestion supplemental to the explanation of the singular distribution of some of the arctic plants as demonstrated by Darwin, and so exceedingly well exemplified by Nathorst.

And so we have in the vegetation of the "Barren Grounds" a picture of the arctic flora, as it is now, with its fascinating little flowers adorning the tundras and possessed by a vitality, for ages unsurpassed, acquired and preserved throughout one of the greatest revolutions in the history of the earth, known as the glacial epoch.

CHAPTER IV. BIBLIOGRAPHY.

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